This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

THE

LONDON

MATRICULATION COURSE

BY

JOHN GIBSON, M.A.

600068200M

BOOKS FOR STUDENTS,

By JOHN GIBSON, M.A., of Bromley, Kent.

Price 3s. 6d. each.

"History Made Easy," and "Geography Made Easy."

Manuals of History and Geography, prepared on an entirely new principle, and intended specially for the Public Examinations.

A Candidate writes:—"I learn more from the 'History Made Easy' in a day than from all the other histories put together in a week."

Another Candidate writes:—"I should think it is the best History ever published for Examination purposes."

Price 5s.; cash, post free, 4s. 4d.

"Preliminary Law Examination Made Easy." 2nd Edition.

REVISED AND ENLARGED.

A COMPLETE GUIDE TO SELF-PREPARATION.

CONTENTS:—Introductory. Chap. I. What Books to Read. II. The various subjects, and how to deal with them. III. Course of Reading. Appendix—I. Test Papers. II. Useful Hints. Index.

Price 6d., post free 7d.

"Guide to the Preliminary Law Examination:"

Published immediately after each Examination.

CONTENTS:—Part I. Articles on the subject of the Preliminary, useful Hints, &c. II. Test Questions on History and Arithmetic. III. Answers to Correspondents. IV. Answers in full to the Questions set at the Preliminary Examination, with Explanations.

Back Numbers can be had.

Price 1s. 6d. each, post free 1s. 7d.

"The Public Examination Latin Grammar,"

AND

"The Public Examination French Grammar."

Graduated Epitomes of Latin and French, prepared specially for the Public Examinations.

⁂ **These are the Second Editions of "Latin and French Grammars Made Easy."**

Published by REEVES & TURNER, 100, Chancery Lane, W.C.

BOOKS FOR STUDENTS,

By JOHN GIBSON, M.A., of Bromley, Kent.

Price 2s. 6d., post free 2s. 9d.

"PRELIMINARY ARMY EXAMINATION MADE EASY."

Prepared on a similar plan to the PRELIMINARY LAW EXAMINATION MADE EASY.

Price 1s., post free 1s. 1d.

"PRELIMINARY ARMY GUIDE."

Published immediately after each Preliminary Army Examination.

CONTENTS:

PART I.—Articles on Subjects connected with the Preliminary Examination.
II.—Test Papers on the Preliminary and further Army Subjects.
III.—Answers to Correspondents, Queries, &c.
IV.—Answers in full to the Questions set at the most recent Preliminary Examination.

The above are published by EDWARD STANFORD, 55, Charing Cross, S.W.

Price 2s., post free 2s. 2d.

"SPECIMEN ESSAYS."

BY J. GIBSON, AND F. R. BURROWS.

Comprising Hints on "How to write an English Composition," and Twelve Essays on various subjects of interest.

These are published for the benefit of Candidates who are weak in their English—a most important branch of the Public Examinations.

Published by REEVES & TURNER, 100, Chancery Lane, W.C.

Preparing for Publication,

"CIVIL SERVICE EXAMINATION MADE EASY,"

Being a Complete Guide to Self-Preparation for the Lower Division Clerkship Examinations.

THE

London Matriculation Course:

BEING A

COMPLETE GUIDE

TO THE

LONDON MATRICULATION EXAMINATION.

BY

JOHN GIBSON, M.A.,

First Class Classics Camb. 1874; *Author of "The Preliminary Law Examination Made Easy," "Gibson's London Matriculation Guide," "The Public Examination Latin and French Grammars," &c., &c.*

LONDON:
REEVES AND TURNER, 100, CHANCERY LANE,
Law Booksellers and Publishers.

1883

BODLEIAN LIBRARY
11 JUL 83
OXFORD.

LONDON:
PRINTED BY C. F. ROWORTH, BREAM'S BUILDINGS, CHANCERY LANE, E.C.

PREFACE.

We have been induced to write this little work in the hope of aiding those many Students who are obliged to read by themselves. The course and plan of work is drawn up on a system which we have found to answer admirably in the case of our own pupils; and we trust that it may be found equally serviceable for self-preparation.

The Test Papers are composed of questions mostly taken from recent Examination Papers. Any hints and suggestions from Teachers, Candidates and others for the improvement of this Manual will be gratefully accepted, and will be duly taken into consideration, should a Second Edition of the Work be required.

Quernmore, Bromley, Kent.
May, 1883.

TABLE OF CONTENTS.

PAGE
Chapter I. INTRODUCTION 1
,, II. WHAT BOOKS TO READ 5
,, III. THE VARIOUS SUBJECTS, AND HOW TO DEAL WITH THEM 7
,, IV. ARRANGEMENT OF WORK 17
,, V. HINTS TO BE OBSERVED IN THE EXAMINATION 26

Appendix I. TEST PAPERS IN ALL THE SUBJECTS 27
,, II. SOLUTIONS TO THE MATHEMATICAL QUESTIONS 86

London Matriculation Examination.

THE Author prepares Pupils for this Examination, Privately, in Class, and by means of Correspondence through the Post.

CLASS TUITION.

The Classes meet at Bromley every day, except Saturday, from 9.30 A.M. to 12 noon; also at 24, Chancery Lane, London, three times a week.

POSTAL TUITION.

The excellence of this system, if faithfully followed out, has been proved in the case of the Author's Pupils over and over again. Full particulars of the Postal system will be found in the Author's Prospectus.

LAST MONTH'S CLASSES.

Special Classes, formed mainly for the benefit of Postal Pupils, 4 but which others can also join, commence a month before each Examination. During this time all the most important points are gone into, and, by working out Test Papers, Students get into the proper way of answering—a point in which so many, even those who are fairly well up in their subjects, fail.

RESIDENTIAL PUPILS.

The Author receives Resident Pupils, to prepare for this Examination, at Bromley, Kent.

Prospectus containing full particulars as to Terms, Regulations, &c., will be sent on application to—

JOHN GIBSON, M.A.,
Quernmore,
Bromley, Kent.

The Intermediate and Final Examinations of the Law Society.

Mr. ALBERT GIBSON, Solicitor,

Prepares Pupils for these Examinations in Class and by means of Correspondence through the Post.

For particulars apply at 35, Southampton Buildings, Chancery Lane, W.C.

THE LONDON MATRICULATION COURSE.

CHAPTER I.

INTRODUCTION.

The London Matriculation Examination is held twice a year—the second week in January, and the third week in June.

It commences on the Monday in the week, and lasts till the following Friday. Every candidate must be at least sixteen years of age, and must send in his certificate of birth to the Registrar-General of the London University, Burlington House, W., *fourteen days* before the commencement of the examination.

A fee of 2*l.* is to be paid by each candidate before entering upon an examination.

The following are the subjects of examination, in *each* of which a candidate must show a competent knowledge in order to ensure his success:—

1. *Latin.*

Under this head is comprised—

(a) A Latin text-book, from which passages for translation are given:

(b) Questions on the history and geography arising out of the subject set:

(c) A paper on general Latin grammar and easy passages of unseen Latin, to be translated into English:

(d) English sentences, to be rendered into Latin.

N.B.—Special stress is laid on accuracy in the last named (d) branch.

2. *Greek* (or *German* as an alternative).

This comprises—

(a) A book of Xenophon or Homer, from which passages are given for translation into English:

(b) Questions in history and geography arising out of the subject:

(c) A paper on Greek grammar, and also containing easy passages of unseen Greek, to be rendered into English.

If German is taken as an alternative for Greek, the paper will contain passages of unseen German to be translated into English, and questions on German grammar.

N.B.—If German is taken up in lieu of French, the grammar will be limited to the accidence.

3. *French*, comprising passages for translation, and grammar questions limited to the accidence.

Sanskrit and Arabic may be taken up instead of Nos. 2 and 3 (either or both); but a candidate must take up *two* languages besides Latin.

4. *The English Language.*

Under this head is comprised—

(a) Orthography:

(b) Writing from dictation:

(c) The grammatical structure of the language.

5. *English History*, up to the end of the seventeenth century.

6. *Modern Geography.*

7. *Arithmetic*, including the ordinary rules, vulgar and decimal fractions, and square root.

8. *Algebra*, comprising the ordinary rules, proportion, simple equations, arithmetical and geometrical progression.

9. *Geometry*, the first four books of Euclid, and riders on them.

10. *Natural Philosophy*, embracing—
    (a) Mechanics:
    (b) Hydrostatics:
    (c) Optics:
    (d) Heat.

11. *Chemistry*—the non-metallic elements.

A list of successful candidates is published on the Monday fortnight following the Examination; and on the following Monday a second list is published, arranged in three divisions—

(1) Those who have obtained Honors, arranged in order of merit:
(2) The first division, arranged in alphabetical order:
(3) The second division, arranged in alphabetical order.

To obtain Honors a candidate must score 1,800 marks out of a maximum of 2,800.

The minimum of marks for the first division is 1,400; for the second division 1,200.

Thus we see that students have a formidable task before them. Still it is by no means an insurmountable one, even for the average candidate.

What is required is regular and systematic work, conducted on the proper lines.

We shall endeavour in the following pages to put our readers in a fair way to obtaining the desired end, by mapping out a course of study for them, recommending them the most suitable text-books for their purpose, and familiarising them with the examination by a series of graduated test papers, to be worked out by them from time to time. The course mapped out by us is regulated for a period of six months' study. Should candidates be pressed for time, and able only to give three months to special preparation, they must do in a week the work arranged by us for a fortnight.

Of course we take it for granted that a candidate has a fair all-round knowledge to start with. Failing this, he must give at least a year to the work; and in that case he will take a month over the subjects allotted by us to a fortnight's work.

CHAPTER II.

WHAT BOOKS TO READ.

Of course, in this matter there must be a variety of opinion; and we can do no more than mention those books, which in our tuition experience have proved most adequate for the purpose. These are:—

(1) *In Latin:*

Public School Latin Primer, Public Examination Latin Grammar, and Arnold's Latin Composition, Part I.

The student should also have a Classical Dictionary, Smith's Smaller History of Rome, and a good Ancient Atlas.

(2) *In Greek:*

Wordsworth's Greek Primer, Smith's Initia Graeca.

We recommend, also, Smith's Smaller History of Greece.

(3) *In German:*

Otto's Grammar and Conversation Book.

(4) *In French:*

Public Examination French Grammar, Brachet's Historical French Grammar, De Fivos' Selections for Translation.

(5) *In English History:*

The Student's Hume, and History Made Easy.

(6) *In Geography:*

Geography Made Easy, and a good Modern Atlas.

(7) *In Algebra:*

Todhunter's Algebra, or Hamblin Smith's Algebra.

(8) *In Arithmetic:*

Brook Smith's Arithmetic.

(9) *In Geometry:*

Todhunter's Euclid.

(10) *In Natural Philosophy:*

Wormell's Natural Philosophy, and Newth's First Book of Natural Philosophy.

(11) *In Chemistry:*

Roscoe's Chemistry (4*s.* 6*d.* edition).

Armed with the above, the student may face the task before him with boldness and confidence; for, after all, a good selection of text-books is half the battle.

We shall now proceed to give an account of the various subjects, and how to deal with them.

CHAPTER III.

THE VARIOUS SUBJECTS, AND HOW TO DEAL WITH THEM.

---

1. LATIN.

(a) *Latin Subject.*

IN translating the Latin text we recommend the student not to use any translation at first. He should hammer out the meaning by aid of dictionary, grammar and common sense, and merely use a translation afterwards, to enable him to express himself in good language. Most "cribs" are not translations at all; they are merely verbal renderings, literal and un-English. What the examiners require is a translation into good readable flowing English, not too literal, and not too free, but preserving a happy medium between the two. Those who are very backward, however, will require to use a translation at the outset; otherwise they will not be able to make any sense at all of the Latin. To such students we recommend the following most successful plan:—

Copy out—say twenty or thirty lines—from a good translation. Then, by means of dictionary and common sense, find out how the Latin words fit in, and put over each English word or phrase its equivalent in Latin. By adopting this plan you will get familiarised with the Latin, the forms of the words, &c., and also be performing a very useful memory exercise.

(b) *The History and Geography arising out of the Subject.*

Since the Examiners do not, as a rule, stray away from the exact subject-matter of the text, you will not require anything very elaborate under this heading. Get up a life of the Author in question carefully; look up in your Roman History all the events referred to in the text, consulting, where necessary, the Classical Dictionary. Then find out every place mentioned in the text in your Classical Atlas, and, where possible, its modern name. Lastly, draw sketch maps, from time to time, of the scene of operations covered by the subject in question.

(c) *Latin Grammar and Unseen Translation Paper.*

With regard to the Latin Grammar but little requires to be said. Most of the questions are usually of a fairly straightforward nature; and careful getting up of the text-books recommended, together with occasional test papers, will suffice for the purpose.

In doing Unseen Translation three things are necessary—(i) intelligence to find out the context, *i. e.* the subject treated of in the passage under consideration; (ii) a grammatical analysis of each sentence, *i. e.* splitting it up into its component parts and seeing how they all hang together; (iii) readiness of expression, to put what you have found out into good English.

Perfection in this art of Unseen Translation can only be attained by regular and repeated practice. You should try your hand on different authors, taking them in rotation, *e.g.* Caesar, Ovid, Virgil, Livy, &c., and you will find it an excellent plan to read through quickly, with a translation, some other author, besides the one you are taking up for examination; in order to familiarise yourself with the Latin language, and to help yourself to see at a glance the drift of a Latin Extract.

(d) *Translation of English into Latin.*

Here we come to by far the most difficult item under this heading. You must learn up the Latin syntax thoroughly, and practise regularly from Arnold the rendering of English sentences into idiomatic Latin. You must translate quickly, and do as many sentences at a sitting as you possibly can. It is only in this way, by constant practice and by doing a great many sentences, that you will be able to make sure of success in this most important branch of the examination—upon accuracy in which the examiners lay very great stress.

2. GREEK.

(a) The remarks we have made as to Latin apply equally to Greek.

The student should get up his Greek grammar carefully before attempting the translation subject; for Greek is such a rich language and contains so many varieties of form, and is so puzzling in the matter of augments, reduplications and so on, that to tackle the translation before getting up the grammar thoroughly will entail much loss of time and cause a feeling of despondency in consequence of the uphill task. When once the grammar, however, has been fairly mastered, the translation of Homer (provided a Homeric dictionary be used explaining the forms of the Ionic dialect) or of Xenophon will not present any very great difficulty.

(b) Constant reference must be made to the classical dictionary, the Greek history and the ancient atlas in a similar manner to that suggested under 1 (b).

(c) In getting up the grammar, you will do well to compare the Greek declensions with the Latin, pari passu, also the adjectives and pronouns. You will find this a great help. In doing the verbs pay very great attention (i) to the characteristic letters of the conjugation; (ii) to the augments, especially in the case of compound verbs; (iii) to the different modes of reduplication. Note also, very carefully, the different cases governed by the different prepositions and the difference of meaning in each instance. You should also pay great attention to the declension of irregular nouns, such as πόλις, ἀνήρ, ναῦς, both in Attic and Ionic Greek.

In unseen translation the same remarks apply as given under 1 (c).

3. German.

This is a difficult subject and requires a proportionately large amount of time to be devoted to it. You must practise translation from German into English most assiduously; and you will do well to read some good standard work in German as well as translate extracts from various authors. In the grammar department, you cannot do better than take the lessons as marked out by Otto in turn, and get them up thoroughly. You must pay particular attention to the plurals and genders of nouns and to the termination of the adjective, according as it is preceded by the definite or indefinite article or possessive pronouns, or used with a noun without any prefix. The irregular verbs must also be carefully learnt; and, if you take up German instead of Greek, you must pay great attention to the syntax as well as to the grammar of the language.

4. French.

Much the same plan should be followed out here, as in German. Practise frequently the rendering of extracts from French authors into good idiomatic English, and read also a good standard work, in order to familiarise yourself with the language and attain a facility of expression. The grammar questions, though sometimes of an elementary nature, have lately been of a more historical and difficult type, and require a considerable amount of practice and care.

5. The English Language.

This is what may be called an un-get-at-able subject. The papers set in the examination vary so much in general character and in detail, that it is difficult to know exactly what will be wanted. We may, however, be pretty safe in assuming that analysis will be required; and hence we should practise this from time to time, according to the system laid down by Dr. Morris. Generally, also, some English sentences are given to verify or correct. This involves a knowledge of syntax, which in consequence should be carefully got up. We would also direct special attention to the connection of the English language with other languages of kindred origin. The pronouns, too, should be carefully studied, especially in reference to their suffixes and their original form and meaning. Also a thorough knowledge of the case-forms is highly desirable. We would recommend plenty of practice in Test Papers of varied questions as the best mode of preparation for the examination ordeal in this subject.

We conclude that most candidates are sufficiently well up in orthography and dictation; otherwise, that they would not think of presenting themselves for this examination. Still, in case any candidate is weak in these subjects, he will do well to practise a short piece of dictation every day, and read plenty of English, in order to correct his spelling by his eye, should he be a bad speller. In case of bad writing, we advise the utmost care in every piece of writing that is done, and practise on ruled paper, till a fair standard of excellence is attained. Remember that writing and spelling are taken into account all through the examination. Hence you cannot be too careful in sending up well-written, neat and workmanlike papers.

6. English History.

It is wonderful how ignorant most Englishmen are of the history of their own country—mainly owing to their never having been taught English history properly when at school. This is a subject which, if read as it should be, will grow in interest every day. You should take the history in periods; and first of all read the period in question in Hume, or a similar history, then condense your knowledge by means of "History Made Easy," and finally make notes from memory on your own account—in fact, analyse what you have read in the text-books. This done, work out a good Test Paper on each period in succession; and after you have been through the course of detailed papers, do two or three containing general questions on the whole amount taken up, *i. e.* to the reign of Queen Anne. Take care to express yourself in good English; and do not let your sentences be too long.

7. Modern Geography.

The questions set in this subject are generally of an easy and straightforward nature: still it will not admit of neglect. Your best plan will be to draw sketch maps of each country in turn (not too elaborate, but accurate), and fill in the chief mountains, rivers, bays, capes and coast towns. Pay particular attention to England, Scotland and Ireland, and to the coast-line of Europe. A good atlas, combined with the "Geography Made Easy," is all that you will require in the way of text-books for this department.

8. Arithmetic.

The sums usually given in arithmetic are of a problematical and common sense nature, and such as are not treated of in a great many text-books. Brook Smith's Arithmetic is by far the best for the purpose that has come under our notice. Special attention should be paid to the method of working out proportional part, train and clock sums, also per-centages, stocks and square root. Wherever it is possible, take unity as the standard up to which you should work; where this is impossible, you must take x to represent the number required.

9. ALGEBRA.

In this branch of the examination there are two most important things to be borne in mind and followed out: (i) knowledge of book work generally, and of formulae in particular; (ii) constant practice in papers of miscellaneous questions. You should pay great attention to the solution of simultaneous equations, to geometrical and arithmetical progression in all their variety of shape and form, and to equational problems. Remember that in this subject, almost more than in any other, unremitting practice is absolutely necessary to bring your efforts up to anything approaching perfection.

10. GEOMETRY.

The student must bear in mind that under this head is comprised, not merely the text-book of Euclid (which indeed is now a very small part of the matter), but a thorough acquaintance with the laws and principles of geometry, to enable him to work out the various problems and "riders" submitted to him—which, indeed, of late years have formed the principal ingredient in the papers set. Very few propositions proper—*i.e.* as contained in Euclid—have been given; and even the few that have appeared have been dressed and tricked out with such subtlety that they are at best propositions in disguise, and almost as puzzling to the tiro as regular "riders." To solve the latter with readiness and facility is doubtless to a great extent a knack; and some candidates will never, even with the best tuition, do anything more than attain a decent mediocrity in this art. Still, a certain standard, sufficient to ensure success at the examination, is within the reach of all; and, to help our readers to the end in view, we will give a few hints as to the cardinal points to be observed in this subject:—

(1) Read over the problem given most carefully, so as to have a definite idea of the data, on which you are to build up your proposition, and of the conclusion which is to be drawn from those data.

(2) If the problem is not given as a "rider" to a definite proposition, try and make out from the figure which you draw in accordance with the data allowed you, the particular proposition of Euclid, on which the proof depends; and adjust your line of argument accordingly.

(3) If you cannot see your way to a solution by arguing from the data supplied you, try the reverse process, reasoning backwards from the conclusion to be drawn to the premises given; and thus, if possible, supply the work required between the data and the conclusion.

(4) Finally, after you have discovered the means of proof, shorten the process if you can, making your argument as concise and succinct as possible.

By carrying out these hints and practising regularly a number and variety of riders, of which several will be found at the end of Todhunter's Euclid, you will in due course naturally, and, as it were, imperceptibly acquire a kind of knack in solving such problems as you may expect to be submitted to you at your examination.

11. Natural Philosophy.

Here we have another "bugbear" to Matriculation candidates. The subject is a somewhat deceptive one; it looks easy, but is really far from being so. A very great many candidates fail every year in this branch of the examination: and you therefore must pay particular attention to it. There are four main divisions of this subject—(i) Statics; (ii) Dynamics; (iii) Hydrostatics; (iv) Light and Heat.

The first branch is the most important of all; and a thorough knowledge of this branch will repay you well and lighten your work considerably in the other divisions. You must be very careful of the definitions, and get up the enunciations accurately. The parallelogram of forces will probably trouble you a good deal at first; but when once mastered you will wonder how it was that you did not understand it sooner. When studying light and heat, you will find it very advantageous to supplement from reading by practical experiments in the laboratory, if there is one at hand. Indeed, for the proper understanding of the subject, laboratory work is almost indispensable. Do not be afraid of working out plenty of examples; the more you work out, the better grip you will have of the subject: in fact it is only by solving a large number of questions that you will find yourself at all at home in it.

12. Chemistry.

Candidates have been known to boast of having passed the examination in this subject without seeing a single experiment, and by dint of sheer grind at book work during the week immediately preceding the examination. We need hardly say that such "cram" as this is worse than useless, even though for the time being it may bring success. This subject, like the rest, must be studied thoroughly and systematically. Here again the laboratory will be called into requisition; as practical experiments will be found absolutely necessary for the proper explanation of the subject. With such a good text-book as that of Roscoe, and the use of a fairly well-furnished laboratory, excellent progress ought to be made; so that very few remarks are called for from us. We would only suggest that particular attention be paid to the composition of air and water, the preparation of chlorine, phosphorus, iodine, sulphur and carbon, and the nature and properties of flame.

CHAPTER IV.

ARRANGEMENT OF WORK.

The course of work, which we now proceed to map out, is arranged for six months. In case a candidate requires a year for preparation (as he will if he is at all backward), then the work allotted by us to a fortnight must be extended over a month. If, on the other hand, he is pressed for time and can only devote three months to the special preparation, then he must do in a week the work for which we, in the following scheme, allow a fortnight:—

First Fortnight's (Month's or Week's) Work.

Latin.—Do one-eighth of Latin Text-Book: Nouns in Latin Grammar. First ten Exercises in Arnold's Composition, Part I. Practise Unseen Translation once a week.

Greek.—Do one-eighth of Greek Text-Book: Nouns in Greek Grammar. Practise Unseen Translation once a week.

German.—Do first six lessons in Otto. Practise Translation every other day.

French.—Do Nouns in French Grammar. Practise Translation every other day.

English Language.—Do Nouns in English Grammar. Practise Dictation twice a week.

English History.—Do Roman Period.

Modern Geography.—Do Europe (generally) and Definitions.

Arithmetic.—Do first four Rules and Square Measure.

Algebra.—Do first four Rules and Bracket Sums.

Geometry.—Do Definitions, Postulates and Axioms, and Book I. Propositions 1—26, with riders on them.

Natural Philosophy.—Parallelogram of Forces.

Chemistry.—Roscoe, Lessons 1 to 3.

At end of Fortnight do Test Papers A in all subjects.

Second Fortnight's (Month's or Week's) Work.

Latin.—Do one-eighth of Latin Text-Book. Adjectives in Latin Grammar. Exercises 11—20 in Arnold. Translation (unseen) as before.

Greek.—One-eighth of Greek Text-Book. Adjectives in Greek Grammar. Translation (unseen) as before.

German.—Otto, Lessons 7—12. Translation as before.

French.—Adjectives in French Grammar. Translation as before.

English Language.—Adjectives in English Grammar. Dictation as before.

English History.—Saxon Period.

Modern Geography.—England and Wales.

Arithmetic.—Vulgar Fractions.

Algebra.—Simple Equations.

Geometry.—Euclid, Book I. Propositions 27—48, with riders on them.

Natural Philosophy.—Polygon of Forces. Parallel Forces and Centre of Gravity.

Chemistry.—Roscoe, Lessons 4 to 6.

At end of Fortnight do Test Papers B in all subjects.

Third Fortnight's (Month's or Week's) Work.

Latin.—One-eighth of Latin Text-Book. Pronouns in Latin Grammar. Exercises 21—30 in Arnold, Part I. Translation (unseen) as before.

Greek.—One-eighth of Greek Text-Book. Pronouns in Greek Grammar. Translation (unseen) as before.

German.—Lessons 13—18 in Otto. Translation as before.

French.—Pronouns in French Grammar. Translation as before.

English Language.—Pronouns in English Grammar. Dictation as before.

English History.—Norman Period.

Modern Geography.—Scotland and Ireland.

Arithmetic.—Decimal Fractions.

Algebra.—Resolution into Factors.

Geometry.—Euclid, Book II. and riders on it.

Natural Philosophy.—Machines, Balances and Pulleys.

Chemistry.—Roscoe, Lessons 7 to 9.

At end of Fortnight do Test Papers C in all subjects.

Fourth Fortnight's (Month's or Week's) Work.

Latin.—One-eighth of Latin Text-Book. Numerals in Latin Grammar. Exercises 31—40 in Arnold, Part I. Translation (unseen) as before.

Greek.—One-eighth of Greek Text-Book. Numerals in Greek Grammar. Translation (unseen) as before.

German.—Lessons 19—24 in Otto. Translation as before.

French.—Numerals in French Grammar. Translation as before.

English Language.—Numerals and Adverbs in English Grammar. Dictation as before.

English History.—Henry II. to Richard II.

Modern Geography.—France, Germany, Belgium and Holland.

Arithmetic.—Proportion.

Algebra.—G. C. M. and L. C. M.

Geometry.—Euclid, Book III. Propositions 1—20 and riders on them.

Natural Philosophy.—The Inclined Plane and Machine Work.

Chemistry.—Roscoe, Lessons 10 to 12.

At end of Fortnight do Test Papers D in all subjects.

Fifth Fortnight's (Month's or Week's) Work.

Latin.—One-eighth of Latin Text-Book. Regular Verbs in Latin Grammar. Exercises 41—50 in Arnold, Part I. Translation (unseen) as before.

Greek.—One-eighth of Greek Text-Book. Regular Verbs in Greek Grammar. Translation (unseen) as before.

German.—Lessons 25—30 in Otto. Translation as before.

French.—Regular Verbs in French Grammar. Translation as before.

English Language.—Verbs in English Grammar. Dictation as before.

English History.—Henry IV. to Richard III.

Modern Geography.—Italy, Spain and Portugal.

Arithmetic.—Interest.

Algebra.—Involution and Evolution.

Geometry.—Euclid, Book III. Propositions 21 to end, with riders on them.

Natural Philosophy.—Velocity, Motion and Falling Bodies.

Chemistry.—Roscoe, Lessons 13 and 14.

At end of Fortnight do Test Papers E in all subjects.

Sixth Fortnight's (Month's or Week's) Work.

Latin.—One-eighth of Latin Text-Book. Irregular Verbs in Latin Grammar. Exercises 51—60 in Arnold, Part I. Translation (unseen) as before.

Greek.—One-eighth of Greek Text-Book. Anomalous Verbs in Greek Grammar. Translation (unseen) as before.

German.—Lessons 31-36 in Otto. Translation as before.

French.—Irregular Verbs in French Grammar. Translation as before.

English Language.—Conjunctions and Prepositions in English Grammar. Dictation as before.

English History.—Tudor Period.

Modern Geography.—Russia, Turkey, Greece.

Arithmetic.—Discount.

Algebra.—Fractions.

Geometry.—Euclid, Book IV. and riders on it.

Natural Philosophy.—Attwood's Machine, Momentum, Newton's Third Law.

Chemistry.—Roscoe, Lessons 15 and 16.

At end of Fortnight do Test Papers F in all subjects.

Seventh Fortnight's (Month's or Week's) Work.

Latin.—One-eighth of Latin Text-Book. Adverbs, Prepositions and Conjunctions in Latin Grammar. Exercises 61—70 in Arnold, Part I. Translation (unseen) as before.

Greek.—One-eighth of Greek Text-Book. Prepositions in Greek Grammar. Translation (unseen) as before.

German.—Lessons 37—42 in Otto. Translation as before.

French.—Adverbs, Prepositions and Conjunctions in French Grammar. Translation as before.

English Language.—Syntax.

English History.—Stuart Period.

Modern Geography.—Norway, Sweden, Denmark, Austria and Switzerland.

Arithmetic.—Proportional Parts.

Algebra.—Simultaneous Equations.

Geometry.—Euclid, Book I. and riders on it.

Natural Philosophy.—Transmission of Pressure, Bramah Press, &c.

Chemistry.—Revise First Fortnight's Work.

At end of Fortnight do Test Papers G in all subjects.

Eighth Fortnight's (Week's or Month's) Work.

Latin.—One-eighth of Latin Text-Book. Syntax in Latin Grammar. Exercises 71—80 in Arnold, Part I. Translation (unseen) as before.

Greek.—One-eighth of Greek Text-Book. Verbs in μι, and Contracted Verbs in Greek Grammar. Translation (unseen) as before.

German.—Lessons 43 to 48 in Otto. Translation as before.

French.—Syntax in French Grammar. Translation as before.

English Language.—Revise Nouns and Adjectives in English Grammar. Dictation as before.

English History.—Revise Roman and Saxon Periods.

Modern Geography.—Asia (generally).

Arithmetic.—Profit and Loss.

Algebra.—Quadratic Equations.

Geometry.—Euclid, Book II. and riders on it.

Natural Philosophy.—Specific Gravity and Density.

Chemistry.—Revise Second Fortnight's Work.

At end of Fortnight do Test Papers H in all subjects.

Ninth Fortnight's (Week's or Month's) Work.

Latin.—Revise first third of Latin Text-Book. Revise Nouns, Adjectives and Pronouns in Latin Grammar. Revise Exercises 1—20 in Arnold. Translation (unseen) as before.

Greek.—Revise first-third of Greek Text-Book. Revise Nouns, Adjectives and Pronouns in Greek Grammar. Translation (unseen) as before.

German.—Lessons 48 to end in Otto. Translation as before.

French.—Revise Nouns, Adjectives and Pronouns in French Grammar. Translation as before.

English Language.—Revise Pronouns, Numerals and Adverbs in English Grammar. Dictation as before.

English History.—Revise Norman Period.

Modern Geography.—India, China and Siberia.

Arithmetic.—Stocks.

Algebra.—Arithmetical Progression.

Geometry.—Book III. and riders on it.

Natural Philosophy.—Atmospherical Pressure, Barometer and Pumps.

Chemistry.—Revise Third Fortnight's Work.

At end of Fortnight do Test Papers I in all subjects.

Tenth Fortnight's (Week's or Month's) Work.

Latin.—Revise second third of Latin Text-Book. Revise Numerals and Verbs in Latin Grammar. Revise Exercises 21—40 in Arnold. Translation (unseen) as before.

Greek.—Revise second third of Greek Text-Book. Revise Numerals and Verbs in Greek Grammar. Translation (unseen) as before.

German.—Revise Lessons 1 to 18 in Otto. Translation as before.

French.—Revise Numerals and Verbs in French Grammar. Translation as before.

English Language.—Revise Verbs.

English History.—Revise Plantagenet Period.

Modern Geography.—Africa.

Arithmetic.—Square Root.

Algebra.—Geometrical Progression.

Geometry.—Book IV. and riders on it.

Natural Philosophy.—Mirrors.

Chemistry.—Revise Fourth Fortnight's Work.

At end of Fortnight do Test Papers J in all subjects.

Eleventh Fortnight's (Week's or Month's) Work.

Latin.—Revise last third of Latin Text-Book. Revise Adverbs, Conjunctions and Prepositions in Latin Grammar. Translation (unseen) as before.

Greek.—Revise last third of Greek Text-Book. Revise Prepositions in Greek Grammar. Translation (unseen) as before.

German.—Revise Lessons 19—36 in Otto. Translation as before.

French.—Revise Adverbs, Prepositions and Conjunctions in French Grammar. Translation (unseen) as before.

English Language.—Revise Prepositions and Conjunctions in English Grammar. Dictation as before.

English History.—Revise Tudor Period.

Modern Geography.—North America.

Arithmetic.—Cube Root.

Algebra.—Revise Simple, Simultaneous and Quadratic Equations.

Geometry.—Revise Books I. and II.

Natural Philosophy.—Refraction and Lenses.

Chemistry.—Revise Fifth Fortnight's Work.

At end of Fortnight do Test Papers K.

Twelfth Fortnight's (Week's or Month's) Work.

Latin.—Revise whole of Latin Text-Book. Revise Syntax in Latin Grammar. Translation (unseen) as before.

Greek.—Revise whole of Greek Text-Book. Revise Verbs in μι and Contracted Verbs. Translation (unseen) as before.

German.—Revise Lessons 37 to end in Otto. Translation (unseen) as before.

French.—Revise Syntax in French Grammar. Translation (unseen) as before.

English Language.—Revise Syntax in English Grammar. Dictation as before.

English History.—Revise Stuart Period.

Modern Geography.—South America and Oceania.

Arithmetic.—Chain Rule.

Algebra.—Revise Arithmetical and Geometrical Progression.

Geometry.—Revise Books III. and IV.

Natural Philosophy.—Effects of Heat.

Chemistry.—Revise Sixth Fortnight's Work.

At end of Fortnight do Test Papers L.

CHAPTER V.

HINTS TO BE OBSERVED IN THE EXAMINATION.

1. READ over the whole paper carefully first of all, marking those questions which you can do with ease and commencing at once with them. This will leave you time to think over the questions which you cannot answer so readily.

2. Read over each answer carefully as soon as done, and then put it away.

3. Do not stray away from the question, or introduce irrelevant matter; and, if you cannot answer the whole of a question, do a part of it, if possible.

4. Be very careful to write neatly and legibly, and mind the spelling and punctuation.

5. Do not make guesses; to do so is worse than leaving a question altogether untouched.

6. Before handing in your paper, see that all the answers are arranged in their proper order.

APPENDIX I.

TEST PAPERS IN ALL THE SUBJECTS.

[In doing these papers you are advised to adopt the following plan:—Do all the questions you can first from memory; and then get up the answers to the rest, and fill them in. Finally, enter them (question and answer in succession) into a note-book, so as to have them ready to read over just before the Examination.]

1.—LATIN GRAMMAR.

A.—Nouns.

I. Decline in sing. and plur. acer vir; alacris virgo; nobile tempus.

II. Give instances of nouns used in plural only, also of nouns varying (a) their meaning, (b) their gender in the plural.

III. Give gen. sing., dat. plur., gender and meaning of:—caro, supellex, dos, iter, fornix, pecus, os, tellus, pecten, sol, porticus, spes.

IV. Give rules for genders of nouns of third declension.

V. What nouns of first and second declensions contract the gen. plur. into -ûm?

VI. Give instances of nouns of third declension forming the acc. sing. in -im.

B.—Adjectives.

I. Classify adjectives and give an instance of each kind. What adjectives make the gen. in -ius, and the dat. in -i?

II. Give the rule for comparison of adj., and mention the chief exceptions, with examples.

III. Compare dives, juvenis, senex, magnus, multus, nequam, beneficus, dubius, sacer, providus.

IV. What adj. are compared by means of magis and maxime?

V. How do adverbs differ from adj. in their comparison? Compare prae, diu, saepe, magnopere, graviter, multum.

VI. What ideas are expressed by the terminations -ax, -ilis, -bilis, -cundus, -inus, -bundus?

C.—PRONOUNS.

I. Classify pronouns, and illustrate each class.

II. Distinguish between hic, iste and ille; uter and uterque; alter and alius; quisquam, quisquis and quisque.

III. Decline idem, quis and iste.

IV. Mention all the compounds of quis that you can, giving the meaning of each.

V. Give the Latin for neither, both, anyone you will, the former, the latter, each of two, which of two, several.

VI. Give rules for the use and construction of the relative and reflexive pronouns.

D.—NUMERALS.

I. Classify numerals, and give an instance of each kind.

II. Give rules for the use and construction of mille and millia.

III.—Put into Latin:—Two camps; One letter (litterae); Ten thousand men.

IV. How are numbers above 100,000 expressed? Illustrate.

V. Give the Latin for 21, 105, 3070, 964.

VI. Write down the distributive numerals from 1 to 12.

E.—VERBS.

(i) *Regular.*

I. How many conjugations of verbs are there, and how are they severally distinguished? Illustrate your answer.

II. Define the terms transitive, intransitive, deponent, supine, gerund, gerundive, and give instances of each.

III. Mention the different ways of forming the perfect tense in Latin.

IV. What parts of a verb must be known in order to conjugate it?

V. What participles are wanting in Latin, and how is this want supplied?

VI. Explain the terms: mood, tense, voice. Mention intransitive verbs that take an accusative of kindred meaning. How are intransitive verbs used in the passive?

F.—VERBS.

(ii) *Irregular.*

I. Define and give instances of semi-deponent, quasi-passive, inceptive, desiderative, frequentative, defective and anomalous verbs.

II. Write down the perf. act. (1st per. sing.), and the past participles of: condo, domo, elicio, pario, figo, fingo, vinco, vincio, tego, texo, meto, volvo, gigno, caedo.

III. Conjugate the pres. indic. of inquam, aio and edo (I eat).

IV. Go through the imperative of nolo, eo and fio.

V. Mention the changes of letters undergone in the following cases:—

(a) A preposition combined with a verb;
(b) A simple verb combined with a preposition.

VI. Mention past participles of deponent verbs used in a passive sense.

G.—ADVERBS, PREPOSITIONS AND CONJUNCTIONS.

I. Classify adverbs, and give an instance of each kind.

II. How many classes of prepositions are there? Mention those which take two cases, and explain the difference of meaning with each case.

III. Distinguish between co-ordinative and sub-ordinative conjunctions, and give instances of each.

IV. Give a list of conjunctive particles that require the subjunctive mood.

V. Mention the various changes undergone by prepositions in composition.

VI. Explain the various meanings of prae, pro, de, and ex.

H.—SYNTAX.

I. Write down and illustrate the principal rules of Latin syntax.

II. Mention, with examples, four different ways in which the ablative case may be used in Latin.

III. Define and illustrate the following:—Ablative absolute; dative of purpose; dative of agency; duration of time; elliptic genitive.

IV. Give a full account of (a) oratio obliqua, (b) sequence of tenses.

V. How are time, place, space and price defined in Latin?

VI. Mention the principal uses of the conjunctive mood.

◆

2.—GREEK.

A.—NOUNS.

I. Mention the number and characteristics of the declensions in Greek.

II. Decline in full λεώς, ναῦς, ἀνήρ, γυνή.

III. Give the gen. sing. and dat. plur. of ἀγών, πόλις, κέρας, γίγας, ἄναξ, τεῖχος, ποιμήν.

IV. Give some account of the main features of the Ionic and Doric dialects.

V. Decline πόλις and υἱός both in Attic and Ionic Greek.

VI. Give rules for the formation of the dat. plur. of the third declension.

B.—Adjectives.

I. Classify adjectives, and give an instance of each kind.

II. Decline μέγας, πόλυς, ἀληθής.

III. What is the general rule for the comparison of adjectives? Mention and illustrate the chief exceptions.

IV. Compare μέγας, μικρός, πολύς, πέπων, πιών, ἅρπαξ, φίλος, ἀφῆλιξ, σόφος, ἱερός.

V. Decline ἥσσων, χείρων and πλείων, giving all the forms in use.

VI. Decline in combination ἱλέως θεός, εὔχαρις ἐλπίς, μέλαν ἅρμα.

C.—Pronouns.

I. What is meant by adjectival and substantival pronouns? Give instances of each.

II. Decline ὅστις, οὗτος, ἀλλήλω.

III. Distinguish between τις and τίς· οὗτος, αὐτός and ὁ αὐτός· τόσος and τοῖος· οἷος and ποῖος.

IV. Decline ἐγώ, σύ and ἕ, giving both the Attic and Ionic forms.

V. What is the Reflexive Pronoun in Greek? Decline it in all genders, singular and plural.

VI. Give the Greek for any one, no one, whoever you will, both, neither, which (of two), each (of two).

D.—NUMERALS.

I. Write down the Greek cardinals from 1 to 20.

II. From what roots do the Greek numerals come? Trace back the first six to their earliest forms.

III. Decline εῖς, δύο and τρεῖς.

IV. Give the Greek for 18, 27, 101, 50,000.

V. What are the ordinals corresponding to the numbers 21, 37, 90 and 500?

VI. Put into Greek:—

I have lost two thousand men.

The enemy were slain up to the number of five thousand.

This happened in the thirtieth year.

E.—VERBS.

(i) *Regular.*

I. How many conjugations are there, and how are they severally distinguished? Illustrate your answer.

II. Give a full account of augments and reduplication.

III. Apply the principles of augment to the following verbs:—ἄγω, ὁράω, ἀμφισβητέω, ἀμφιέννυμι, περιέχω, οἰκοδομέω.

IV. Write out the 2nd aor. active and 1st aor. passive Paradigms of τύπτω and πείθω.

V. Distinguish in meaning and use between the imperfect and aorist. What is meant by strong and weak aorists?

VI. Conjugate the 1st aor. imper. pass. and the 2nd aor. subjunctive middle of ἄγω.

F.—VERBS.

(ii) *Irregular.*

I. Write down the first pers. sing. of the fut., perf. and 2nd aor. of:—λαμβάνω, τέμνω, ὁράω, λαγχάνω, θνήσκω, τρέχω, βλώσκω, γιγνώσκω, γίγνομαι.

II. Parse the following:—*κλέψειαν*, *τετάχαται*, *ἑάλων*, *ἀμφέξει*, *ἧσαι*, *βῆναι*.

III. Mention verbs having (a) a present tense with perfect signification, (b) a perfect tense with present signification.

IV. Write out the Paradigms of 2nd aor. active and perf. pass. of:—*αἰσθάνομαι*, *βάλλω*, *πυνθάνομαι*, *αἱρέω*.

V. Conjugate the future optative of *ἀπεχθάνομαι* and *κτάομαι*.

VI. Give a list of verbs that are transitive in some tenses and intransitive in others.

G.—Prepositions.

I. Make out a scheme of Greek prepositions, according to the number of cases that they severally govern, and give the difference of meaning with each case.

II. Give the different ideas expressed by *ἐπί*, *παρά* and *περί*, according to the cases with which they are constructed.

III. What prepositions are compared? Give the comparative and superlative in each case.

IV. What is the force of *μετά* and *κατά* when compounded with verbs?

V. Distinguish between *πρὸς ταῦτα* and *πρὸς τούτοις*. What is the meaning of *οὐκ ἔστι παρὰ ταῦτ' ἄλλα*?

VI. What cases are governed by *ὑπό*? Illustrate each case by an example.

H.—Verbs in *μι* and Contracted Verbs.

I. Conjugate the pres. indic. active of *τίθημι*, and the 2nd aor. subj. middle of *δίδωμι*.

II. Which tenses of *ἵστημι* are transitive and which intransitive?

III. Write out the Paradigms of the 1st aor. active of ἵημι, and the 1st aor. middle of δείκνυμι.

IV. Conjugate the pres. imperative active of φιλέω, and the pres. subjunctive passive of χρυσόω.

V. Distinguish between εἶμι and εἰμι, and write out the imperfect indic. of each verb.

VI. Put into Greek:—
Be thou honoured.
I will give you this.
Let him not be blinded (τυφλόω).

◆

3.—GERMAN.

A.—Otto, Lessons 1—6.

I. Decline ein, mein, der, unser, dieser, jener.

II. Give the gen. sing. and dat. plur. of:—Frau, Feder, Buch, Graf, Knabe, Blume.

III. Write down the nom. plur. of Mann, General, Himmel, Bediente, Namen, Garten.

IV. Decline, in sing. and plur., der Soldat, die Tochter, das Bäumchen.

V. What are the genders of nouns ending in -ling, -schaft, -ich, -heit, -keit, -en?

VI. How are diminutives formed? Give instances.

B.—Otto, Lessons 7—12.

I. Decline das Kind, das Dorf, das Haus.

II. What cases are required with:—aus, durch, während, vor, über, wegen?

III. What are the plurals of:—Vetter, Staat, Gott, Burg, Kaufmann, Besorgniss?

IV. Give general rules for determining the genders of German nouns.

V. Distinguish between the meanings of the following nouns, according as they are masc. or neut.:—Band, Erbe, Bauer, Schild, Chor, Verdienst.

VI. How are proper nouns declined? Give the gen. sing. of Fritz, Luise, Maria, Augustus, Heinrich, Solon.

C.—Otto, Lessons 13—18.

I. Decline derselbe, welcher, wer, aller, Ihr, einige.

II. Conjugate the pres. indic. and imperf. subj. of haben, werden, sein, können, sollen and müssen.

III. Give the German for:—I shall have; I shall have had; He should have done it; He might do it; You must do it; They had not been obliged to do it.

IV. Give rules for the inflection of an adjective, according as it is preceded by the definite or indefinite article or possessive pronoun.

V. Decline throughout: Der gute Mann; Meine schöne Frau; Ein altes Haus.

VI. Put into German: Had you not been sad? Shall we not have bad weather? Why have you been unhappy? She could not have read the book. It may rain.

D.—Otto, Lessons 19—24.

I. Give the rule for comparison of adjectives; and compare gut, hoch, alt, süss, edel, stark.

II. Put into German: He is not so old as I; The more the merrier; May 10th, 1883; Two years and a half; It is half past five; The tenth man in my army.

III. How many kinds of verbs are there? Give instances of each kind.

IV. Conjugate the imperf. and first future indic. of loben and reden.

V. Put into German: I shall be praised; I should be praised; I should have been praised; I was praised; I had been praised.

VI. When is the passive formed with werden and when with sein? Distinguish between wer and welcher; and mention under what circumstances der is used as a relative.

E.—Otto, Lessons 25—30.

I. What is meant by irregular verbs; and what general principles are there which help us in the conjugation of such verbs?

II. Conjugate the imperfect indic. and the present subjunctive of: geben, essen, sitzen, stehen, befehlen, werfen, nehmen, sterben, kommen.

III. Write down the pres. and imperf. indic. (1st pers.) and the past part. of: binden, finden, springen, leiden, greifen, schneiden, steigen, heissen, bleiben.

IV. From what verbs do the following come:—bewogen, verloren, geboten, genossen, zog, fuhr, wuchs, erscholl, floss, bot?

V. What is the force of the following prefixes:—ent-, zer-, miss-, voll-, wider?

VI. Give a list of simple separable particles.

F.—Otto, Lessons 31—36.

I. When is the preposition separable from a compound verb, and when not?

II. Put into German:—I have just come in; Take the letter back; If you spend too much money, I shall be angry.

III. Distinguish between úbersetzen and übersétzen. What verbs in German are compounded with sein instead of haben?

IV. Give six instances of reflective and impersonal verbs. Put into German: It is going to rain. Are you not ashamed of your conduct? There are some people who believe nothing.

V. Classify adverbs in German, and give instances of each kind.

VI. Give the German for:—A fortnight ago; This day week; From time to time; Twice a day; For the last time; Every other day.

G.—Otto, Lessons 37—42.

I. Give a list of prepositions governing (a) the accusative; (b) the dative; (c) the genitive case; (d) the dative and accusative.

II. Under what circumstances is the definite article used in German where it is not used in English?

III. Put into German: You may do this; This might not be true; He is just going out; I was going to speak.

IV. In what special senses is the verb lassen used in German? Illustrate by examples.

V. Give particulars as to the use and construction of sollen and dürfen.

VI. Distinguish between the ideas expressed by the imperfect and perfect tenses.

H.—Otto, Lessons 43—48.

I. Give a list of conjunctions and verbs that are followed by the subjunctive mood.

II. When is the infinitive used with zu, and when without? Give instances.

III. How is the idea of purpose expressed in German? Illustrate.

IV. Give a full account of the present and past participles, their use and construction.

V. What cases are required with the following verbs: befehlen, bringen, empfehlen, dienen, anstehen, entreissen?

VI. What prepositions follow these verbs: zählen, bedecken, antworten, fragen, wohnen, spielen, warnen?

E.—Verbs.

(i) Regular.

I. How many conjugations are there in French, and how are they severally distinguished? Give instances.

II. What verbs are compounded with être instead of avoir?

III. When is the past participle inflected in a tense compounded with avoir? Illustrate fully.

IV. Conjugate (a) negatively, (b) interrogatively, (c) negatively and interrogatively, the fut. indic. of finir.

V. What are meant by the primitive tenses of a verb? Show how the preterite definite differs from the imperfect.

VI. What do you know of the personal suffixes?

F.—Verbs.

(ii) Irregular.

I. Give in a tabular form (a) the pres. indic. 1st pers.), (b) the fut. indic. (1st pers.), (c) the past part. (masc. and fem. sing.) of—Asseoir, taire, venir, pouvoir, offrir, mourir, croire, croitre, naitre.

II. Conjugate (a) interrogatively, (b) negatively, the fut. indic. of s'en aller.

III. Write down the 2nd pers. sing. of the imperative, and the 3rd pers. plur. of the imperf. subjunctive of—Rendre, dire, envoyer, apercevoir, éteindre, savoir, vivre, mouvoir.

IV. Give rules for the orthography of verbs ending in -cer, -ger, -yer.

V. How do the French avoid the use of the passive? Illustrate your answer by examples.

VI. Put into French:—I am going to speak; I have just spoken; I should speak; I should have spoken; I long to depart.

G.—Adverbs, Prepositions and Conjunctions.

I. Give the general rules, and the main exceptions, for the formation of adverbs in French.

II. Form adverbs from the adjectives bref, vieux, courageux, lent, présent, constant, seul, beau, sage, joli.

III. Compare bien, mal, peu.

IV. Distinguish between dans and en; parmi and entre; devant and avant; vers and envers; par and de.

V. Give the French for:—Until; in order that; before that; since; although; provided that.

VI. Mark the precise meaning of à in the following sentences:—Une salle à manger. Ce n'est pas à la mode. C'est à vous de commencer. Je l'ai demandé à mon père. Nous renonçons à notre dessein. Je me promènerai à cheval.

H.—Syntax.

I. When is the definite article used in French where it is not used in English? Illustrate by examples.

II. When are adjectives uninflected? Give instances.

III. How can we determine when we should employ Il est and when C'est to represent "It is"?

IV. Give rules for the syntax of ce, celui and cela.

V. When is (a) the present participle, (b) the past participle, inflected?

VI. What is the meaning and use of ne .. pas; ne .. point; ne .. que; ne .. guère; ne .. jamais; ne .. plus?

◆

5.—ENGLISH LANGUAGE.

A.—Nouns.

I. Show by a genealogical tree the connection between English and the other languages of the Indo-European Group.

II. Is the English alphabet perfect? If not, why not? Explain fully.

III. Classify the letters of the alphabet according to their sounds.

IV. What traces remain in English of case-forms? Give a full account of the possessive case.

V. Classify nouns; and reduce the number of parts of speech to the smallest possible.

VI. Mention the different ways of forming (a) the fem. of nouns, (b) the plural of nouns. What nouns have two forms in the plural?

VII. What ideas are expressed by the following suffixes:—-ness, -dom, -hood, -kin, -ock, -ster, -tion, -ty?

VIII. Which of the following words represent a singular, and which a plural, form:—Riches, wisdom, tidings, news, alms, summons?

B.—Adjectives.

I. Give a definition of an adjective which shall include *tall, third, nine, some, the.* Classify adjectives according to their functions.

II. Explain the force and origin of the terminations -ly, -ish, -ine, -en, -y, -al, -ic, -ous, -less, -some.

III. How are adjectives compared? What adjectives do not admit of regular comparison? Give six instances of irregular formations.

IV. Do you consider *the* a definite article or an adjective? Give your reasons in full.

V. Distinguish in meaning and origin between further and farther; later and latter; elder and older.

VI. Give examples of (a) double superlatives, (b) the superlative of eminence.

C.—Pronouns.

I. Classify pronouns, and give an instance of each kind.

II. State and explain the anomalies and difficulties observable in the various forms of pronouns compounded with various forms of the word "self."

III. Decline in sing. and plur., and account for the various inflexions of: thou, he, she. Discuss the use of the pronouns *you* and *ye*.

IV. Discuss the formation and use of the words: who, which, what, that, its.

V. Under what circumstances is the word "that" preferable to "who" or "which" as a relative pronoun?

VI. Take the personal, possessive, interrogative, and relative pronouns, and show, with examples, which of them can be used *substantively*, which *adjectively*, and which in *both* constructions.

D.—NUMERALS AND ADVERBS.

I. Distinguish between cardinal, ordinal and distributive numerals, and give instances of each.

II. The English *three* is the German *drei*, and the Latin *tres*. Explain the law that is illustrated by the above words.

III. Account for the separate forms of two and twain, and trace the etymology of ten, twelve, hundred, thousand, first, dozen, score.

IV. Discuss the formation of both, eleven, five, second, fourth.

V. Classify adverbs (a) as to meaning; (b) as to form. What is the chief use of adverbs in language?

VI. Give a list of adverbs derived from numerals.

E.—VERBS.

I. What is the proper function of a verb in language? Classify verbs as (a) strong; (b) weak. Is this classification satisfactory and complete? If not, what other would you suggest?

II. Explain the terms mood, tense, transitive, intransitive, irregular, defective verbs.

III. Discuss the forms may, can, should, would, might, durst.

IV. Under what circumstances are the auxiliaries "shall" and "will" respectively used to represent a future tense?

V. What are the various meanings of the verb "owe"? How is it conjugated? Trace the connection between this verb and the verb "own."

VI. What do you know of the infinitive and gerunds?

F.—PREPOSITIONS AND CONJUNCTIONS.

I. Classify prepositions (a) according to their form, (b) according to their meaning.

II. What is meant by co-ordinative and subordinative conjunctions? Give instances of each.

III. Mention the various ways and meanings in which *but*, *as* and *that* can be employed.

IV. Discuss the word "to" in the following combinations:— To-morrow; Early to bed; Go to; Such a to-do; A house to let.

V. Analyze the compound prepositions. Show, with illustrations, what prepositions can be used adverbially.

VI. What are verbal prepositions? Give six examples, and show how they came to be used prepositionally.

G.—SYNTAX.

I. Discuss the propriety of such forms as moneyed, comfortable, positivist, telegram, bicycle.

II. Quote some rules of concord in English syntax. How far is the number of such rules in any language determined by the number and variety of its grammatical inflections?

III. Use each of the following phrases correctly in a sentence of your own construction: Better than he; Better than him; Than whom; And which; As good as I; As good as me; The wiser man; Would that; Sixty head.

IV. Explain the syntax of the following:—He was paid a shilling. I taught him Latin. He walked twenty miles. That is a house of mine. It grieves me to hear this. Who runs may read. There is no man here but honours you.

V. Point out anything faulty or objectionable in the composition of these words: Witticism, streamlet, height, unreserved, huntress, he-goat, fertilize, pureness.

VI. Correct or justify: They were very fond of each other. Avoid those kind of things. He was neither learned in the languages nor philosophy. Stick no bills. You will not have as many friends as me. That's him. The river has overflown its banks. This was the easiest matter of the two. I do not know whether you are aware of this. Are either of these men your friend?

◆

6.—HISTORY.

A.—Roman Period.

I. What attracted the Romans to Britain? Give an account of the chief invasions with results.

II. How did the Romans (a) divide, (b) govern Britain?

III. Who was Julius Agricola, and what did he do to improve this country?

IV. What remains are still left of the Roman occupation? How long did it last, and what are the benefits that we derive from it?

V. What do you know of the introduction of Christianity into these islands?

VI. Explain the following:—Vallum Antonini; Council of Arles; Druidism; Hallelujah Victory.

B.—Saxon Period.

I. Who was the first Saxon king in this country? Give a list, with dates, of the chief sovereigns of this line.

II. Write a life of Dunstan and mention his ecclesiastical and other acts.

III. Explain the terms "Heptarchy" and "Octarchy," and mention the settlements comprised under each head.

IV. Write a life of one of the kings (a) of Mercia, (b) of Wessex.

V. Give some account of the reign of Ethelred II. and of the troubles which he brought on the country.

VI. How was the Saxon line interrupted and how restored?

VII. Who was Earl Godwin? Describe the cause and issue of his quarrel with Edward the Confessor.

VIII. What arrangement did Edward make for a successor? and who eventually came to the throne on his death?

IX. Explain:—Danegelt; Offa's Dyke; Danelagh; Peter's Pence; Witenagemot.

C.—Norman Period.

I. Give a list of Norman sovereigns, with the dates of accession of each.

II. Give a full account of the Civil War in Stephen's reign, and a particular description of the Battle of the Standard.

III. Mention the conflicts that arose in this period between the Church and State.

IV. What rebellions arose during William I.'s absence in Normandy, and what steps did he take to repress them?

V. Give an account of the origin of the Crusades, and mention what great men were connected with them.

VI. Explain the following: Curfew Bell; Feudal System; Domesday Book; Forest Laws; Odo's Rebellion; Treaty of Winchester.

D.—Henry II. to Richard II.

I. Derive the term Plantagenet. Who were the heads of the house? Give a list of Plantagenet kings, with dates of accession.

II. Give an account of Henry II.'s quarrel with Becket.

III. What French possessions did England acquire during this period? Show how foreign marriages affected the policy of some of the Plantagenet kings.

IV. Whence arose the French war in the reign of Edward III.? Mention the battles fought, and the name and terms of the treaty that concluded it.

V. Give an account of the rebellion in the reign of Richard II.

VI. Explain the following:—The Lollards; Praemunire; Statute of Treason; the Provisions of Oxford; Constitutions of Clarendon; Magna Charta.

E.—Houses of York and Lancaster.

I. Trace the descent of Henry IV. Had he any right to the throne? If so, what?

II. Describe the rebellions in the reign of Henry IV.

III. Trace the cause, course and result of the War with France in the reign of Henry V.; and give the name and terms of the Treaty that concluded it.

IV. Describe the character of Henry VI., and compare it with that of any other sovereign before or after him. Whom did he marry, and what issue did he have?

V. What caused the Wars of the Roses? Mention the chief battles fought, with dates and results.

VI. Describe the rebellion of Jack Cade, and compare it with any other rebellions before or after.

VII. Who was the King Maker? Whence did he derive his title? What became of him?

VIII. Explain the following:—Siege of Orleans; Murder of the Princes; Battle of Bosworth; Hotspur; Battle of Shrewsbury.

F.—Tudor Period.

I. Give a list, with dates, of the Tudor Sovereigns.

II. Describe the course of the Reformation under the Tudors.

III. How many wives had Henry VIII.; what was their respective issue; and which of the children came to the throne?

IV. Give some account of Lambert Simnel and Perkin Warbeck; and compare their rising with any other rebellion either before or after.

V. Describe the persecutions in the reign of Mary.

VI. Elizabeth's reign has been called the "paragon" reign in English History. Examine this statement, and justify it, if you can.

VII. Mention the chief literary men who shone in this period.

VIII. Explain the following:—Statute of Six Articles; Act of Supremacy; Suppression of the Monasteries; The Pilgrimage of Grace; Flodden Field; Field of the Cloth of Gold; Court of Star Chamber.

G.—Stuart Period.

I. Trace the descent of James I. What claim had he to the throne? What plots were formed against him, for what reasons, and with what results?

II. Trace the general and immediate causes that led to the civil war in the reign of Charles I. Mention the chief battles fought, with dates and results.

III. Estimate the character of Oliver Cromwell, also his foreign policy. Compare the latter with that of Elizabeth.

IV. Describe the parliaments summoned by Charles I., and give a particular account of the Long Parliament.

V. How was it that Charles II. came to be restored to the throne?

VI. Give an account of the Dutch Wars in this period.

VII. What caused William of Orange to be invited over to this country? Describe his landing.

VIII. Explain the following:—Petition of Right; Habeas Corpus; Solemn League and Covenant; Humble Petition and Advice; Treaty of Dover; Massacre of Glencoe; Act of Settlement; the Bloody Assize; Declaration of Indulgence.

◆

7.—GEOGRAPHY.

A.—Europe generally and Definitions.

I. Define the terms: Latitude, Longitude, Equator, Antipodes, Trade Wind, Neap Tide, Affluent, Cape, Gulf Stream, Ecliptic.

II. Describe Europe generally, mentioning its chief peculiar characteristics and naming the chief mountains and rivers.

III. Describe the course, from source to mouth, and mention the chief towns on either bank of the Rhone, Rhine and Danube.

IV. What are the most N. and S. points of the Continent? Give its greatest length, breadth and area, and the proportion of land to water.

V. Mention in order the chief bays, capes, towns and river mouths on W. coast.

VI. Describe the exact position and importance of: Hammerfest, Toledo, Astrakhan, Archangel, Navarino, Lodi, Barcelona, Toulon, Bordeaux, Bayeux, Trieste, Nijni Novgorod.

B.—England and Wales.

I. Describe the general configuration of England, and give a particular account of its watershed.

II. Trace the course of the Thames, Severn and Trent. Mention the chief towns on each bank of these rivers.

III. Mention, in order, the chief capes, river mouths, bays and towns on E. coast.

IV. Describe the mountain features of the country, and name the chief ranges, with their directions.

V. Give the greatest length, breadth and area of the country. From and to what points would the first two be reckoned?

VI. Describe the exact position and importance of:—Stilton, Kidderminster, Senlac, St. Michael's Mount, Wantage, Naseby, Axholme, Axminster, Llandudno, Sunderland.

C.—SCOTLAND AND IRELAND.

I. Give the most northern and southern points of both countries; also the length, breadth and area.

II. Describe the river system of Scotland and the mountain system of Ireland.

III. Trace the course, from source to mouth, and mention the chief towns on either bank of the Tweed, Clyde, Shannon, Blackwater.

IV. Mention in order the capes, bays, river mouths and towns which a vessel would pass coasting from Caithness to Berwick.

V. How many counties are there in Scotland and Ireland respectively? Mention the names and positions of the provinces of Ireland.

VI. Describe the position and importance of:—Limerick, Culloden, Prestonpans, Bannockburn, Londonderry, Belfast, Drogheda, Paisley, Coldstream, Scone, Cork and Carrick.

D.—FRANCE, GERMANY, BELGIUM AND HOLLAND.

I. Describe the boundaries of France, and mention the chief political departments, with the capital of each.

II. Give a full account of the river system of Germany; mention also the chief mountain ranges.

III. Trace the course and mention the chief towns on the banks of the Rhine, Loire, Elbe and Seine.

IV. Indicate the watershed of France separating the rivers flowing N.W. from those flowing S.E.

V. Give a list, in order, of the bays, capes, coast towns and river mouths on the coasts of France, Belgium and Holland.

VI. Describe the position and importance of:—Toulon, Hamburg, Ostend, Bruges, Jemappes, Lyons, La Rochelle, Dresden, Leyden, Bordeaux, Arles, Rheims, Orleans, Aix-la-Chapelle, Utrecht.

E.—Italy, Spain and Portugal.

I. Give the boundaries of Italy and Spain, and describe the latter physically and politically.

II. Trace the course, from source to mouth, and mention the chief towns on either bank of:—Po, Douro, Ebro and Arno.

III. Mention places in Spain and Portugal made famous in the Peninsular war.

IV. Describe the mountain system of Italy.

V. Give a list, with explanation of their respective positions, of the groups of islands off the coasts of Italy and Spain.

VI. Describe the position and importance of:—Lodi, Barcelona, Cintra, Marengo, Toledo, Ostia, Milan, Saragossa, Ajaccio, Palermo.

F.—Russia, Turkey and Greece.

I. Describe the physical features of Russia, with special reference to its river system.

II. Give a list, with their respective positions, of the islands round Greece.

III. Trace the course, from source to mouth, and mention the chief towns on the banks of:—The Volga, Danube and Don.

IV. Mention the political divisions of Turkey, and point out the changes that have taken place in her territory during the last ten years.

V. What countries or seas are separated by—(a) Dardanelles; (b) The Bosphorus; (c) Strait of Yenikale?

VI. Describe the position and importance of:—Archangel, Adrianople, Navarino, Astrakhan, Odessa, Novgorod, Zante.

G.—NORWAY, SWEDEN, DENMARK, AUSTRIA AND SWITZERLAND.

I. Give the boundaries of all five countries, and the capital of each.

II. Describe the physical features of Norway and Sweden, with special reference to the mountain and river system.

III. Give a list of the islands off the coasts of Norway, Sweden and Denmark.

IV. Trace the course of the Glommen, Danube and Rhine from source to mouth. Mention the chief towns on either bank.

V. Mention the chief openings off the coasts of Norway and Sweden.

VI. Give the exact position and importance of the following:—Hammerfest, Trondheim, Elsinore, Upsal, Altona, Kiel, Basle, Trieste, Schaffhausen, Cracow, Prague.

H.—ASIA (GENERALLY).

I. Describe the general configuration of Asia, and mention its prevailing physical features. Give its greatest length, breadth and area.

II. Give a list, in order, starting from the N.E. corner, of the various groups of islands off the coasts of Asia.

III. Draw a map of British India, putting in the chief rivers and mountains and ten of the principal towns.

IV. Trace the course of the rivers Ganges, Hoangho and Obi. Mention the directions in which they severally flow, and the chief towns on their respective banks.

V. Write down in order the bays, river mouths and towns that would be passed in a coasting voyage from Ceylon to Yeddo.

VI. Give particulars as to the position and importance of:—Delhi, Samarcand, Nankin, Petropauvolski, Cabul, Teheran, Colombo, Katmandoo, Rangoon, Yokohama.

I.—India, China and Siberia.

I. Mention the boundaries of the Chinese Empire, and its political divisions, with the capital of each.

II. Describe the situation and extent of Siberia, and give a full account of its river and mountain systems.

III. Explain the term "Himalayas." What is the name of their summit, and its height? How does the highest point compare with the summit of the Andes?

IV. Trace the course from source to mouth, and mention the chief towns on both banks of the following rivers:—Yenisei, Yang-tse-kiang and Indus.

V. What is a delta? Mention the most important deltas in these countries.

VI. Where (exactly) are the following, and what is their respective importance:—Agra, Tobolsk, Tomsk, Pondicherry, Cawnpore, Canton, Peshawur, Allahabad?

J.—Africa.

I. Draw an outline map of the coast of Africa, putting in the chief bays, capes, river mouths and towns.

II. What is known as to the source of the Nile? Describe the course of this river, and its delta. Mention other large and important deltas in this or other countries.

III. How is Africa politically divided? Mention the chief divisions and the capital of each.

IV. Give a full description of the Great Sahara.

V. What alterations have taken place in Southern Africa during the last few years?

VI. State the exact position and importance of:—Coomassie, Port Elizabeth, Pietermaritzburg, Zanzibar, Damietta, Thebes, Gondar, Tunis, Algiers, Sierra Leone.

K.—NORTH AMERICA.

I. Mention the chief islands in the Atlantic Ocean off the coast of this country and give a full and particular account of Newfoundland.

II. Describe the course, from source to mouth, and mention the chief towns on the banks of the following rivers:—Mississippi, St. Lawrence, Mackenzie, Fraser.

III. Describe British North America, and mention its political divisions, giving the capital of each.

IV. Give a full account of the mountain system of N. America.

V. How many divisions are comprised in the United States? Mention those that are called New England States and give the capital in each case.

VI. Give particulars as to the position and importance of:—San Francisco, Ohio, Cincinnati, Vera Cruz, Baltimore, Washington, St. John's, Halifax, Quebec.

L.—SOUTH AMERICA AND OCEANIA.

I. Mention, in order, the chief bays, capes, river mouths and towns that would be passed in a coasting voyage from Demerara to Monte Video.

II. Give a full account, both physically and politically, of Brazil.

III. What are the divisions of Australia? Draw a map of the country, showing these divisions plainly marked and the capital of each.

IV. What do you know of the extent, population and government of Van Diemen's Land?

V. Mention the Dutch and Spanish possessions in Malaysia.

VI. Where are the following places and for what are they severally famous:—Auckland, Labuan, Buenos Ayres, Quito, Rio Janeiro, Paramaribo, Cayenne, Potosi, Santiago, Villa Real.

◆

8.—ARITHMETIC.

A.—First Four Rules and Square Measure.

I. Define arithmetic, numeration and notation. How are numbers classified? Explain our decimal system, and show how it is made to express all numbers.

II. Express in figures: five thousand seven hundred and seven billions, five hundred and thirty-four thousand five hundred and thirty-eight millions, four hundred and twenty-four thousand and four; and in words, 567,894,321,070,543.

III. Find a number such that if you diminish it by 56, and divide it by 55, you will get 2,854 for the quotient, and 0 for the remainder.

IV. Find the number of seconds from noon on September 19th to 7 a.m. on December 18th.

V. A number of things at *3l.* *4s.* *5¼d.* each, cost 5,647*l.* 18*s.* 11¼*d.* How many were there?

VI. What is the measure of a quantity, and what the multiple? Explain the method of proving multiplication "by casting out the nines."

VII. A piece of timber contains 507½ square feet. What length must be cut off it to give 24 feet in breadth?

VIII. Required the amount of carpet, and the cost of carpeting a room 19 ft. 6 in. long, and 12 ft. 3 in. broad, at 3*s*. 9*d*. a yard, the carpet being 15 inches wide.

B.—Vulgar Fractions.

I. Which is the greater, $\frac{1}{19}$ of a £ or $\frac{1}{20}$ of a guinea? what is the difference between them? What fraction of 100*l*. is 3*l*. 17*s*. 6*d*.?

II. What fraction of 1*l*. is 7*s*. 6½*d*.? Find the value of $\frac{5}{9}$ of 729*l*. 18*s*. 9*d*. Express in seconds $\frac{7}{13}$ of a year, taking the length of the year as 365 days 6 hours.

III. Express by equivalent fractions, with the least common denominator, $\frac{5}{7}$, $\frac{11}{12}$, $\frac{13}{14}$, $\frac{14}{15}$, $\frac{17}{20}$, $\frac{19}{21}$.

IV. Simplify $\dfrac{\frac{2\frac{1}{2}}{54} + \frac{1}{8} - \frac{1}{216} + \frac{1}{12}}{\frac{1}{2} + \frac{1}{3} - \frac{1}{6}}$

V. Reduce to its lowest terms $\frac{19890}{25935}$; and add together $\frac{7}{15}$, $\frac{8}{39}$, $\frac{12}{35}$, $\frac{17}{52}$, $\frac{3}{14}$.

VI. Find the value of $\dfrac{[\frac{5}{6} + \frac{1}{2}(\frac{2}{3} - \frac{1}{2}) - \frac{6}{7}(\frac{4}{5} + \frac{1}{9})]}{[\frac{3}{4}(\frac{7}{8} - \frac{1}{2}) - \frac{1}{3}(\frac{1}{7} - \frac{1}{10})]}$ th part of 44*l*. 17*s*.

C.—Decimals.

I. Add together 1·465, ·0095, 37·15, 28·457 and 16·1685, and divide the sum by ·0296.

II. Express 17 lbs. 10 ozs. 6 dwts. 15 grs. as a decimal of 1 lb. troy and as a decimal of 1 lb. avoirdupois.

III. Divide ·0075 by 25·6, and state the principle upon which you fix the position of the decimal point in the quotient.

IV. Find the quotient of $\cdot\dot{2}\dot{3}$ divided by $\cdot2\dot{8}7\dot{5}$.

V. Reduce 3*l*. 12*s*. 2¼*d*. to the decimal of 11 guineas.

VI. Reduce the recurring decimal $\cdot2\dot{2}8571\dot{4}$ to a fraction in its lowest terms.

D.—Proportion.

I. Define Proportion, and state the rules for working out a Proportion sum.

II. If a package weighing 7½ cwt. be carried 125 miles for 14*s*. 7*d*., how much will be charged for the carriage of 3 tons, 15 cwt. for a distance of 200 miles?

III. If I spend 6 guineas a week, what must my income be to allow me to lay by 300*l*. per annum?

IV. If a train travelling 36 miles an hour performs a distance in 3½ hours, how long will another train going 48 miles an hour be in completing half the distance?

V. A gentleman, after paying 8*d*. in the £ income tax, finds he has a net income of 759*l*. 18*s*. 8*d*. What is his nominal income?

VI. If 20 horses and 196 sheep can be kept 18 days for 151*l*. 10*s*., what sum will keep 15 horses and 72 sheep for 8 days, supposing 5 horses to eat as much as 76 sheep?

E.—Interest.

I. Find the simple interest on 5,000*l*. for 6 years at 3½ per cent.

II. At what rate, simple interest, will 300*l*. amount to 373*l*. 10*s*. in 7 years?

III. What sum of money put out at simple interest for 3½ years at 4¼ per cent. will amount to 1,497*l*. 4*s*. 1*d*.?

IV. Find the compound interest on 100*l*. for 3 years at 5 per cent. per annum. If the difference between the simple and compound interest on a sum of money for 3 years at 5 per cent. per annum be 9*l*. 6*s*. 9¾*d*., find the sum.

V. What must be the rate per cent. that 73*l*. may amount to 100*l*. in 25 years?

VI. Which would be the more productive to the state—an income tax levied at 3 per cent., or at the rate of 7*d*. in the pound? Calculate the tax at the latter rate on an income of 1,755*l*. 10*s*.

F.—Discount.

I. Define discount; distinguish between discount and interest; find the discount on 1,456*l.* 10*s.* for three years at 4½ per cent.

II. What is the present value of 1,374*l.* 10*s.* due three years hence at 4½ per cent. simple interest?

III. The rate of interest being 7 per cent., what is the discount on a sum of 1,356*l.* 14*s.* 4*d.* due three months hence?

IV. The discount on a certain sum of money due fifteen months hence is 6*l.* 4*s.*; find the amount, the rate being 5 per cent.

V. Find the present value of 911*l.* 13*s.* 3*d.* due five years hence at 3 per cent. simple interest.

VI. From a bill of 3*l.* 11*s.* 8*d.* due 18 months hence a tradesman deducts 5*s.*; what is the rate per cent. at which the true discount is calculated?

G.—Proportional Parts.

I. Divide 1,120*l.* among A., B., C. and D., in the proportion of the first 4 units.

II. There are three partners in a concern. The profits for one year are 1,365*l.*, and their shares are as ½, ⅓, ¼. What does each receive?

III. It is required to divide 36 into 3 such parts, that one-half of the first, one-third of the second, and one-fourth of the third may be equal to each other.

IV. Three graziers, A., B., C., agree to hold a pasture in common. A. puts in 8 oxen for 10 months; B. 7 oxen for 12 months; C. 20 oxen for 5 months—at a rent of 66*l.* per annum. How much should they each respectively contribute towards the rent?

V. Alcohol and water being mixed in the proportion of 5·295 parts by weight of the former to 6·027 of the latter; find what weight of each substance is contained in 1℔. of the mixture, and also the weight of a quantity of the mixture which contains 1℔. of water.

VI. Divide 14*l.* 16*s.* 8*d.* between 3 men, 4 women, 5 boys and 6 girls, giving each woman a sixth, each boy a fifth, and each girl a fourth less than the share of each man.

H.—Profit and Loss.

I. If 25 tons of goods are purchased for 37*l.* 10*s.* and sold at 35*s.* a ton, what is the gain per ton?

II. A merchant sells tea to a tradesman at a profit of 60 per cent.; but the tradesman becoming a bankrupt pays only 2*s.* 6*d.* in the pound. How much per cent. does the merchant gain or lose by his sale?

III. A grocer buys some tea at 4*s.* per pound, and some at 5*s.* 6*d.* In what proportion must he mix them, that when he sells the tea at 6*s.* per pound he may gain 20 per cent.?

IV. Two persons buy apples at 1*d.* each; one sells them at 5 for 6*d.*, the other at 6 for 7*d.* Compare the gains per cent. in the two cases.

I.—Stocks.

I. A person has 5,635*l.* stock, the annual interest on which is reduced from 3½ to 3¼ per cent. What does he lose in income by the reduction, and what is his income after it?

II. Wishing to buy a certain number of railway shares, I found that if I bought the shares in the railway (A), which were at 40*l.* a share, I should invest all my money; but if I bought the same number of shares in a railway (B), which were at 45*l.* a share, I should not have money enough by 240*l.* How much money had I to invest?

III. A man bought 500*l.* 3 per cent. stock when consols were at 93½, and after receiving one dividend he sold at 96¾. What did he gain by the transaction?

IV. The price of 3 per cent. consols is 90⅜. What sum must be invested in order to purchase 24*l.* per annum? And what is the rate of interest on the money invested?

V. A person, having invested a sum of money in the 3 per cent. consols, receives annually therefrom 233*l.* After deducting the income tax of 7*d.* in the pound, what is the sum of money? What can the stock be sold for when the consols are at 94⅛?

VI. A person has a sum invested in the 3 per cent. stock, which he sells and re-invests in the 3½ per cents. at 87½. If his income remain the same, what is the price of the 3 per cents.?

J.—SQUARE ROOT.

I. Extract the square roots of 156·25, ·0064, ·064.

II. Explain the rule for pointing in the extraction of the square root of a whole number. If a decimal be a perfect square, the number of decimal places must be even: show this. Extract the square roots of 190,096 and ·081.

III. Extract the square root of 529·092004.

IV. Find the value of $\frac{3}{\sqrt{8}-1}$ to 4 places of decimals.

V. Extract the square root of $41\frac{1}{2}\frac{8}{2}$.

VI. Determine to 5 places of decimals the value of $\sqrt{}$ and of $\frac{1}{1-\sqrt{\cdot\dot{9}}}$

K.—CUBE ROOT.

I. Explain the process of extracting the cube root, and apply it in the case of 4,134,520,125.

II. How is the cube root extracted in the case of decimals and vulgar fractions?

III. Find exactly $\sqrt[3]{47{,}558\frac{2185}{2197}}$.

IV. Find the cube root of $47{,}307\frac{1}{216}$.

V. A cubic foot of water weighs 1,000 ozs. Find the side of a cubical vessel which contains 4 tons 12 cwts. 3 qrs. 10 lbs. 7 ozs.

VI. Find the cube root of 11 to 4 places of decimals.

L.—Chain Rule.

I. Explain what is meant by chain rule, and formulate the method for working out a sum in this rule.

II. If 3 lbs. of tea are worth 4 lbs. of coffee, and 12 lbs. of coffee are worth 40 lbs. of sugar, how many lbs. of sugar are worth 27 lbs. of tea?

III. A. can do as much work in 3 days as B. can do in 4; B. can do as much in 10 days as C. in 12; and C. can do as much in 9 days as D. in 15. How many days' work of D. are equal to 18 of A.?

IV. If 75 thalers = 9 francs; 15 scudi = 81 francs; 270 gulden = 124 scudi; and 10 gulden = 1*l.*; find the number of thalers = 4*l.* 15*s*.

V. A London merchant owes 3,500*l.* to another in Paris. What is his gain if, instead of sending direct, he remits the money from London to Venice, from Venice to Hamburg, and from Hamburg to Paris, the exchange being 1*l.* = 24·6 francs, 19 francs = 10 Hamburg merks, 1 Hamburg merk = 4¼ lire of Venice, and 55½ lire = 1*l.*?

VI. 7 lbs. of beef are worth 8 lbs. of pork; 9 lbs. of pork = 7 lbs. of bacon; 20 lbs. of bacon = 18 lbs. of mutton; and 12 lbs. of mutton = 10 lbs. of cheese. How many lbs. of cheese = 8 lbs. of beef?

◆

9.—ALGEBRA.

A.—First Four Rules and Brackets.

I. Find the value of

$a^3 + b^3 + c^3 - 3abc$ when $a = \cdot 3$, $b = \cdot 7$, and $c = -1$.

II. Divide $a^3 + b^3 + c^3 - 3abc$ by $a + b + c$.

III. Simplify $a + 3b - (5a - 9b) - (4a + 8b) - (-6a + b)$.

IV. Multiply $x^4 - 2x^3a + 4x^2a^2 + 8xa^3 + 16a^4$ by $x - 2a$.

V. Add together $7ax - 3xy$, $4ax - 2xy$, $ax + 7xy$; and divide $x^2 - 5x + 6$ by $(x - 3)$.

VI. From $7x^2 - 8xy + 9y^2$ take $5x^2 + 11xy + 8y^2$.

B.—Simple Equations.

Solve the following equations:—

I. $7x - 10 = 5x - 4$.

II. $\frac{x}{3} - \frac{x}{4} + \frac{x}{6} = 3$.

III. $\frac{x}{5} + \frac{x}{2} - \frac{x}{12} = \frac{2x}{15} + 29$.

IV. $\frac{2x + 1}{3} - \frac{3x - 2}{4} = \frac{x - 2}{6}$.

V. Divide 36 into 2 parts, so that the first subtracted from the second may equal one-half of the whole.

VI. There is a certain number of two digits which is seven times the sum of the digits. The first digit is double the value of the second; and, if their difference be subtracted from their sum, the original number is ten and a-half times the result. Find the number.

C.—Resolutions into Factors.

I. Resolve into factors—

(a) $x^2 - 15x + 50$.

(b) $a^2 + 9ab + 20b^2$.

(c) $2(x + y)^2 - 7(x + y)(a + b) + 3(a + b)^2$.

II. Add together $a(a + b - c)$, $b(b + c - a)$, $c(a + c - b)$.

III. Simplify the following:—

(a) $(x + b)(x + c) - (a + b + c)(x + b) + a^2 + ab + b^2 + 3ax$.

(b) $\dfrac{(a + b)(a + c) - (b + d)(d + c)}{a - d}$.

(c) $\dfrac{18(bc^2 + ca^2 + ab^2) - 12(b^2c + c^2a + a^2b) - 19abc}{2a - 3b}$.

IV. Show that the following results are true:—

(a) $(a + 2b)a^3 - (b + 2a)b^3 = (a - b)(a + b)3$.

(b) $a(a - 2b)^3 - b(b - 2a)^3 = (a - b)(a + b)3$.

D.—G. C. M. AND L. C. M.

I. Define G. C. M. and L. C. M., and show the best methods for solving examples in each of these two rules.

II. Find the G. C. M. of—

(i) $x^2 + 8x + 15$ and $x^2 + 9x + 20$.

(ii) $x^3 - 10x^2 + 26x - 8$ and $x^3 - 9x^2 + 23x - 12$.

(iii) $x^4 - 1$ and $3x^5 + 2x^4 + 4x^3 + 2x^2 + x$.

(iv) $x^2 - xy - 12y^2$ and $x^2 + 5xy + 6y^2$.

III. Find the L. C. M. of—

(i) $4a(a + b)$ and $6b(a^3 + b^3)$.

(ii) $x^3 - 6x^2 + 11x - 6$ and $x^3 - 9x^2 + 26x - 24$.

(iii) $x^2 - 1$, $x^3 + 1$ and $x^3 - 1$.

(iv) $x^2 + 5x + 10$, $x^3 - 19x - 30$ and $x^3 - 15x - 50$.

E.—INVOLUTION AND EVOLUTION.

I. Find the value of the following—

(i) $(ax + by)^3 + (ax - by)^3$.

(ii) $(1 - 3x + 3x^2)^3$.

(iii) $(a + b + c + d)^2 - (a - b + c - d)^2$.

(iv) $(1 - x)^3 (1 + x + x^2)^3$.

II. Find the square roots of—

(i) $36x^6 + 12x^3 + 1$.

(ii) $\dfrac{9x^4 - 24x^2 + 16}{4x^2 - 12x + 9}$.

(iii) $x^4 - 2ax^3 + 5a^2x^2 - 4a^3x + 4a^4$.

(iv) $1 - 2x + 3x^2 - 4x^3 + 5x^4 - 4x^5 + 3x^6 - 2x^7 + x^8$.

III. Find the cube roots of—

(i) $1728x^6 + 1728x^4y^3 + 576x^2y^6 + 64x^7$.

(ii) $x^3 - 3x^2(a + b) + 3x(a + b)^2 - (a + b)^3$.

(iii) $x^6 - 3ax^5 + 5a^3x^3 - 3a^5x - a^6$.

(iv) $1 - 3x + 6x^2 - 10x^3 + 12x^4 - 12x^5 + 10x^6 - 6x^7 + 3x^8 - x^9$.

F.—Fractions.

I. Simplify

$$\frac{a^2}{(a-b)(a-c)} + \frac{b^2}{(b-c)(b-a)} + \frac{c^2}{(c-a)(c-b)}.$$

II. Simplify

$$\frac{x^4 - 9x^3 + 16x^2 + 18x - 8}{x^4 - 8x^3 + 14x^2 - 11x - 12}.$$

III. Reduce

$$\frac{x^3}{(x-1)(x-2)} + \frac{1}{x-1} - \frac{8}{x-2}$$

to its simplest form.

IV. Simplify the expression

$$\frac{a+b}{a-b} + \left(1 - \frac{b}{a}\right) \div \left(1 + \frac{a}{b}\right)$$

V. Reduce to its lowest terms

$$\frac{24x^4 + 14x^3 - 48x^2 - 32x}{30x^4 + 16x^3 - 50x^2 - 24x}.$$

VI. Simplify the following expression, and determine its numerical value when $a = 2b$:—

$$\frac{a}{a+b} + \frac{ab}{a^2 - b^2} - \frac{a^2}{a^2 + b^2} - \frac{a^2b^2}{a^4 - b^4}.$$

G.—Simultaneous Equations.

Solve the following—

I. $5x + 4y = 58$.
$3x + 7y = 67$.

II. $\frac{x}{9} + \frac{y}{8} = 43$.
$\frac{x}{8} + \frac{y}{9} = 42$.

III. $2x + y + z = 13.$
$x + 2y + 3z = 16.$
$3x - 2y + 4z = 14.$

IV. $x + y = 9.$
$x + z = 10.$
$y + z = 11.$

V. $\dfrac{3x + 2y - 3}{4x - 5y + 16} = \dfrac{9}{4}$
$3x = 5y.$

VI. $xy + \dfrac{x}{y} = 10.$
$xy^2 - x = 67.$

H.—Quadratic Equations.

Solve the following quadratics:—

I. $3x^2 - 17x + 10 = 0.$

II. $\dfrac{x}{x + 1} + \dfrac{x}{x + 4} = 1.$

III. $4x - \dfrac{12 - x}{x - 3} = 22.$

IV. $\dfrac{3}{2(x^2 - 1)} - \dfrac{1}{4(x + 1)} = \dfrac{1}{8}.$

V. $a^2x^2 - 2a^3x + a^4 - 1 = 0.$

VI. $\dfrac{1}{x} + \dfrac{1}{x + b} = \dfrac{1}{a} + \dfrac{1}{a + b}.$

I.—Arithmetical Progression.

I. Find the arithmetical mean between 6 and 24.

II. If 1 be the first and 2 the last term of an arithmetical progression of fifty terms, what will be the sum of the progression, and what the sum of its first fourteen terms?

III. Find the sum to *n* terms each of the two arithmetical progressions $1 + 3 + 5 + 7 +$ &c. and $2 + 4 + 6 + 8 +$ &c., and determine, by division or otherwise, the ratio of the former to the latter.

IV. The seventh term of an arithmetical progression is 12, and the twelfth term is 7; the sum of the series is 171. Find the number of terms.

V. The sum of three numbers in arithmetical progression is 12, and the sum of their squares is 66. Find the numbers.

VI. If the sum of n terms of an arithmetical progression is always equal to n^2, find the first term and the common difference.

J.—GEOMETRICAL PROGRESSION.

I. Find the geometrical mean between 6 and 24.

II. Find the seventh term of the geometrical series $\frac{2}{3} + \frac{1}{2} + \frac{3}{8} + \ldots$ and the sum of the n of its terms. Find also the sum of this series continued to infinity.

III. What will be the last term and what the sum of a geometrical progression of ten terms, if the first term be 4 and the common ratio 3?

IV. Find the sum, to $2n$ terms each, of the two geometrical progressions $1 + \frac{1}{3} + \frac{1}{9} + \frac{1}{27} +$ &c., and $1 - \frac{1}{3} + \frac{1}{9} + \frac{1}{27} +$ &c., and determine, by division or otherwise, the ratio of the former to the latter.

V. The sum of the first four terms of a geometrical progression is 40, and the sum of the first eight terms is 3280. Find the progression.

VI. The sum of three terms in geometrical progression is 21, and the sum of their squares is 189. Find the terms.

◆

10.—GEOMETRY.

A.—EUCLID, DEFINITIONS, &c. AND BOOK I. (PROPOSITIONS 1—26.)

I. Define a circle, parallelogram, right angle, trapezium, isosceles triangle, rhombus, rhomboid.

II. The angles at the base of an isosceles triangle are equal.

III. On a given straight line describe an isosceles triangle, such that each of the sides shall be double of the base.

IV. Draw a straight line at right angles to a given straight line from a given point in the latter.

V. Find a point in a given straight line equidistant from two points not on the line.

VI. The straight lines, drawn from the extremities of the base to a point within a triangle, are less than the two sides containing the vertical angle.

B.—EUCLID, BOOK I. (PROPOSITIONS 27 TO END.)

I. Parallelograms on the same base, and on the same side of it, are equal.

II. If the opposite angles of a quadrilateral be equal, the figure is a parallelogram.

III. The complements of a parallelogram are equal.

IV. Find a point in the base of a triangle, such that lines drawn through it, parallel to the sides and terminated by them, shall be equal.

V. The square on the side opposite the right angle in a right-angled triangle is equal to the squares on the sides containing the right angle.

VI. The straight line which joins the middle points of the sides of a triangle is parallel to the base.

C.—EUCLID, BOOK II. AND RIDERS ON IT.

I. Prove by Euclid the algebraical formula $(a + b)^2 = a^2 + 2ab + b^2$.

II. Divide a straight line into two parts, so that the square on one shall be double of the square on the other.

III. Divide a straight line into two such parts, that the rectangle contained by the whole and one of the parts may be equal to the square on the other part.

IV. The sum of the squares on the diagonals of any quadrilateral are equal to twice the sum of the squares on the lines joining the middle points of the opposite sides of the quadrilateral.

V. In any triangle the square on the side subtending an acute angle is less than the squares on the sides containing that angle by twice the rectangle contained by either of these sides and the straight line intercepted between the perpendicular let fall on it from the opposite angle and the acute angle.

VI. If the square on the hypotenuse of a right-angled triangle be double the rectangle contained by the sides, the triangle must be isosceles.

D.—EUCLID, BOOK III. (PROPOSITIONS 1 TO 20 AND RIDERS ON THEM.)

I. If two circles touch one another internally, the straight line which joins their centres, being produced, shall pass through the point of contact.

II. If two circles touch one another internally, and parallel diameters be drawn, the lines joining corresponding ends of these diameters will pass through the point of contact.

III. The diameter is the greatest straight line in a circle; and of the rest that which is nearer the centre is greater than that which is more remote.

IV. Through a given point within a circle draw the shortest chord possible.

V. If a straight line touch a circle, the straight line drawn from the centre to the points of contact shall be perpendicular to the line touching the circle.

VI. Draw parallel to a given straight line a straight line to touch a given circle.

E.—Euclid, Book III. (Propositions 21 to end, with Riders on them.)

I. In equal circles, equal angles stand on equal arcs.

II. Divide a circle into two segments, such that the angle in one segment shall be twice the angle in the other.

III. The angle in a semicircle is a right angle; the angle in a segment greater than a semicircle is less than a right angle; and the angle in a segment less than a semicircle is greater than a right angle.

IV. The straight lines joining the extremities of two parallel chords of a circle are equal.

V. From a given circle cut off a segment containing an angle equal to a given rectilineal angle.

VI. If two circles intersect, the common chord bisects the common tangent.

F.—Euclid, Book IV. and Riders on it.

I. Inscribe a circle in a given triangle.

II. If the inscribed and circumscribed circles of a triangle be concentric, the triangle must be equilateral.

III. Describe an isosceles triangle having each of the angles at the base double of the third angle.

IV. Describe a circle to pass through two given points, and touch a given straight line.

V. Inscribe an equilateral and equiangular quin-decagon in a given circle.

VI. The hexagon formed by joining the middle points of consecutive sides of a regular hexagon is three-fourths of the original hexagon.

G.—Euclid, Book I. and Riders on it.

I. If two triangles have two angles of the one equal to two angles of the other, each to each, and sides adjacent to those equal angles equal, then the triangles shall be equal in all respects.

II. Given the base, one of the angles at the base, and the sum of the sides: construct a triangle.

III. If a straight line falling on two other straight lines makes the interior angles on the same side together equal to two right angles, these two straight lines are parallel to each other.

IV. If the straight lines which bisect the angles at the base of an isosceles triangle meet the sides in D and E, then DE shall be parallel to the base.

V. Straight lines joining the extremities of two equal and parallel straight lines towards the same parts are themselves equal and parallel.

VI. If a quadrilateral have two of its sides parallel, and the others equal but not parallel, show that any two of its opposite angles are together equal to two right angles.

H.—EUCLID, BOOK II. AND RIDERS ON IT.

I. A straight line is divided into two equal and also into two unequal parts. Show that the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

II. The sum of the squares on the sides of a parallelogram is equal to the sum of the squares on the diagonals.

III. If a straight line be bisected and produced to any point, the square on the whole line thus produced, and the square on the part of it produced, are together double of the square on half the line bisected, and of the square on the line made up of the half and the part produced.

IV. In any isosceles triangle, if a line be drawn from the vertex to the base, the square on a side of the triangle shall exceed the square on the line thus drawn by the rectangle contained by the segments of the base.

V. Describe a square that shall be equal to a given rectilineal figure.

VI. Describe a rectangle that shall be equal to a given square and have one of its sides equal to a given line.

I.—Euclid, Book III. and Riders on it.

I. The angle at the centre of a circle is double of the angle at the circumference on the same base, that is, on the same arc.

II. Describe a circle which shall touch a given circle, having its centre on a given line, and pass through a given point on that line.

III. The opposite angles of any quadrilateral figure inscribed in a circle are together equal to two right angles.

IV. If a quadrilateral be described so that its sides touch a circle, show that two of its sides are together equal to the other two.

V. If from any point without a circle two straight lines be drawn, one of which cuts the circle and the other touches it; the rectangle contained by the whole line which cuts the circle and the part of it without the circle shall be equal to the square on the line which touches it.

VI. The circles described on the equal sides of an isosceles triangle as diameters will intersect at the middle point of the base.

J.—Euclid, Book IV. and Riders on it.

I. Describe a square about a given circle.

II. If two tangents to a circle intersect, describe a circle which shall touch both lines and the given circle.

III. Inscribe a regular pentagon in a given circle.

IV. On a given straight line as base describe an isosceles triangle having the angle at the vertex treble of either angle at the base.

V. Inscribe a circle in an equilateral and equiangular pentagon.

VI. Describe a regular hexagon on a given line.

◆

11.—NATURAL PHILOSOPHY.

A.—Parallelogram of Forces.

I. Enunciate and explain the proposition known as "The Parallelogram of Forces."

II. Two forces of the magnitudes 5 and 11 act at angles of 60°, 90° and 120° respectively; compare their resultants in the three cases.

III. Assuming the truth of the parallelogram of forces, show how to find the position and magnitude of the resultant of two parallel forces P and Q acting at different points of a rigid body.

IV. Three forces act along three sides of a parallelogram, ABDC: one from A to B, one from A to C, and the third from B to D, each force being proportional to the side along which it acts. The parallelogram is such that the diagonal AD is perpendicular to the side BD. Find the line of action of the resultant force, and show that its magnitude is equal to one of the given forces.

V. Three cords are tied together at a point. One of these is pulled in a northerly direction with a force of six pounds, and another in an easterly direction with a force of eight pounds. With what force must the third cord be pulled in order to keep the whole at rest?

VI. Define weight, force, pressure, moment of a force about a point.

B.—Triangle and Polygon of Forces, Parallel Forces, Centre of Gravity.

I. Forces of 10 and 20 act along the sides of AB and AC respectively of an equilateral triangle. Find the magnitude of their resultant.

II. Explain the term "centre of gravity." Two heavy particles, weighing respectively three and five ounces, are attached to the ends of a straight rod eight inches long, weighing two ounces; find the centre of gravity of the system.

III. Show, by the method of the "polygon of forces," how to find the resultant of three given forces acting on a point; and prove that to produce equilibrium their directions must lie in the same plane.

IV. A line is drawn across an equilateral triangle of twelve inches side parallel to its base, and so as to cut off one-fourth of its area. Find the distance of the base from the centre of gravity of the remainder.

V. Two parallel forces, P and Q, act at two points in a straight line six inches apart in opposite directions. Their resultant is a force of one pound acting at a point in the line four feet from the larger of the forces P and Q. Determine the values of P and Q.

VI. Squares are described on the three sides of an isosceles right-angled triangle. Determine the centre of gravity of the figure so formed.

C.—Machines, Balances and Pulleys.

I. It is asserted that if a substance be weighed successively from the two ends of a false balance, its true weight will equal the square root of the product of the two apparent weights. Prove this.

II. A mass of 488 grammes is fastened to one end of a cord which passes over a smooth pulley. What mass must be attached to the other end in order that the 488 grammes may rise through a height of 200 centimetres in ten seconds? ($g = 980$.)

III. In a common steelyard, whose mass is twenty pounds, the point of suspension of the body to be weighed is four inches from the fulcrum, while the centre of gravity of the beam is one inch from the fulcrum measured in the opposite direction. If the mass of the sliding weights be 7 lbs., find the distances from the fulcrum of the graduations marked respectively 14 lbs., 28 lbs., 56 lbs. and 112 lbs.

IV. Make careful sketches of (a) a system of (weightless) pulleys, in which 1 lb. balances 32 lbs., and (b) a system of (weightless) pulleys, in which 1 lb. balances 15 lbs., taking care, in each case, that the number of pulleys is the least possible.

V. Describe some form of balance in which the beam is below the scale-pans. A body appears to weigh 24 lbs. when placed in one scale-pan, and 25 lbs. when placed in the other. Find its real weight to three places of decimals.

VI. In a system of pulleys, in which a separate string passes round each pulley, it is found that when the power and the weight are in equilibrium, and the power is caused to descend through eight feet, the weight rises through one foot. Can the mechanical advantage of this arrangement ever be as much as 8? Explain your answer.

D.—The Inclined Plane and Machine Work.

I. A weight rests upon a smooth horizontal plane, and is acted upon by a force equal to the weight of 6 lbs. in a direction inclined obliquely downwards at an angle of 30° to the horizon. Find the magnitude of the horizontal force required to prevent motion.

II. A body weighing 6 lbs. is placed on a smooth plane, which is inclined to the horizon at 30°. Find the two directions in which a force equal to the weight of the body may act to produce equilibrium; also find what is the pressure on the plane in each case.

III. A sphere of wood, loaded at one point with lead, rests upon a plane inclined at an angle of 30° to the horizon, being prevented from sliding down by the friction of the plane. State and explain by a diagram the conditions of equilibrium.

IV. With a wheel and axle a power of 14 lbs. balances 1 ton. If the power descended through 80 inches, through what height would the weight be raised?

V. A body whose mass is 5 kilograms, resting on a smooth plane inclined at 30° to the horizon, is acted on by four forces:—(1) its weight; (2) the reaction of the plane; (3) a force equal to the weight of 2 kilograms acting parallel to the plane and upwards; and (4) a force P acting at an angle of 30° to the plane. Determine the value of P that the body may be in equilibrium.

VI. State the principle of the "triangle of forces." Employ it to construct an inclined plane on which a horizontal force of 3 lbs. will support a weight of 4 lbs., and find the resistance of the plane.

E.—Velocity, Motion, and Falling Bodies.

I. State the three laws of motion and give examples of each.

II. A rifle is fired horizontally with its barrel 5 feet above a lake. When discharged, the ball is found to strike the water 400 feet off. Find approximately the velocity of the ball.

III. If a body is projected upwards with a velocity of 120 feet in a second, what is the greatest height to which it will rise? and when will it be moving with a velocity of 40 feet per second?

IV. A stone is let fall from the top of a railway carriage, which is travelling at the rate of 30 miles an hour. Find what horizontal distance and what vertical distance the stone will have passed through in one-tenth of a second.

V. Two bodies start together from rest and move in directions at right angles to each other. One moves uniformly with a velocity of 3 feet per second; the other moves under the action of a constant force. Determine the acceleration due to this force if the bodies at the end of 4 seconds are 20 feet apart.

VI. A stone dropped into a well reaches the water with a velocity of 80 feet per second, and the sound of its striking the water is heard $2\frac{7}{12}$ seconds after it is let fall. Find from these data the velocity of sound in air ($g = 32$.)

F.—Attwood's Machine, Momentum, Newton's Third Law.

I. In Attwood's machine one of the boxes is heavier than the other by half an ounce. What must be the load of each in order that the over-weighted box may fall through one foot during the first second?

II. Two masses of 48 and 50 grammes respectively are attached to the string of an Attwood's machine; and, starting from rest, the larger mass passes through 10 centimetres in a second. Determine from these data the value of the acceleration due to gravity, your units being centimetres and seconds.

III. Explain and illustrate Newton's Third Law.

IV. A gun weighing 5 tons is charged with a shot weighing 28lbs. If the gun be free to move, with what velocity will it recoil when the ball leaves it with the velocity of 100 feet per second?

V. What is the "kinetic energy" of a moving mechanical system?

VI. A shot of 1,000lbs., moving at 1,600 feet per second, strikes a fixed target. How far will the shot penetrate, the target exerting upon it an average pressure equal to the weight of 12,000 tons?

G.—TRANSMISSION OF PRESSURE, BRAMAH PRESS, &c.

I. Describe an experiment which proves that the upward pressure of a fluid on any substance immersed in it is equal to the weight of the fluid displaced by the substance. Give a sketch showing the arrangement of the apparatus.

II. A wooden vessel 6 in. square, and 6 in. in height, with a neck 2 in. square, and 3 in. in height, is full of water. Find the pressure on the base of the vessel.

III. Describe and illustrate by a diagram the Bramah Press.

IV. A square plate, whose area is 64 square inches, is immersed in sea-water; its upper edge, which is horizontal, being 12 in. below the surface. Determine the whole pressure of the water in the plate when it is inclined at an angle of 45° to the horizon, assuming a cubic inch of sea-water to weigh ·63 ounce.

V. Two vertical tubes, A and B, are connected by a horizontal tube. A is short, and provided with a piston; B is long, and has no piston. The diameter of A is 50 times that of B. What height of water in B will support 1,000 kilogs. in the piston A (a depth of a centimetre produces a pressure of 1 gramme on a square centimetre)?

VI. A cubic foot of water may be assumed to contain 1,000 ounces, while a gallon contains 10 lbs. Two gallons of water are placed in a cylindrical can 10 in. in diameter. Find the whole pressure on the curved surface of the can.

H.—SPECIFIC GRAVITY AND DENSITY.

I. Distinguish clearly between specific gravity and density, and illustrate your answer.

II. A piece of cupric sulphate weighs 3 ounces in vacuo, and 1·86 ounces in oil of turpentine. What is the specific gravity of cupric sulphate, that of turpentine being 0·88?

III. If two liquids that do not mix meet in a bent tube open at both ends, show that when at rest their heights above the common surface of contact are inversely proportional to their specific gravities.

IV. When equal volumes of alcohol (specific gravity = 0·8) and distilled water are mixed together, the volume of the mixture (after it has returned to the original temperature) is found to fall short of the sum of the volumes of its constituents by 4 per cent. Find the specific gravity of the mixture.

V. A piece of metal of specific gravity 9·8 weighs in water 56 grains. What is its true weight?

VI. A body weighing 300 grammes (specific gravity = 5·0) has 100 grammes of another substance attached to it, and the joint weight of the two in water is 300 grammes. Find the specific gravity of the attached substance.

I.—Atmospherical Pressure, Barometer and Pumps.

I. Give a sketch and explain the principle of action of the forcing pump; and show by what modification a continuous stream may be obtained by means of it.

II. An air bubble at the bottom of a pond 10 feet deep has a volume of 0·00006 of a cubic inch. Find what its volume becomes when it just reaches the surface, the barometer standing at 30 inches, and mercury being 13·6 times as heavy as the water of the pond.

III. Enunciate the law connecting the volume and pressure of a given weight of gas. When the height of the mercurial barometer changes from 29·55 inches to 30·33 inches, what is the change in the weight of 1,000 cubic inches of air, assuming that 100 cubic inches of air weigh 31 grains at the former pressure, and that the temperature remains constantly at 0°C?

IV. A barometer tube of uniform bore is 34 inches in length. A small quantity of air is left in the tube above the mercury, so that the barometer registers 30 inches when the true atmospheric pressure is 30·05 inches. What will be the true barometric reading when this barometer registers 28 inches?

V. A diving bell is lowered into water at a uniform rate, and air is supplied by a force pump so as just to keep the bell full without allowing any to escape. How must the quantity (*i.e.* mass) of air supplied per second be varied as the bell descends?

VI. The cylinder of a single-barrelled air pump has a sectional area of 1 square inch. The length of the stroke is 4 inches. The pump is attached to a receiver, whose capacity is 36 cubic inches. Compare the pressure of the air, after eight complete strokes of the pump, with the pressure before commencing the operation.

J.—Mirrors.

I. A candle flame is placed at a distance of 3 feet from a concave mirror formed of a portion of a sphere, the diameter of which is 3 feet. Determine the nature and position of the image of the candle flame produced by the mirror, and state whether it is erect or inverted.

II. Given a concave spherical mirror; how could you find its radius of curvature by optical means alone, and without resorting to geometrical operations?

III. An object 6 inches long is placed symmetrically on the axis of a convex spherical mirror, and at a distance of 12 inches from it. The image formed is found to be 2 inches long. What is the focal length of the mirror?

IV. A man 6 feet high sees his image in a plane mirror hung vertically. The top of the mirror being 6 feet from the ground, determine its smallest length in order that the man may see his full length image in it?

V. The radius of a convex mirror is 6 inches. If the linear dimensions of an object be twice those of its image, where must each be situated?

VI. A luminous point is placed 8 inches from the surface of a plane mirror, and 5 inches from the surface of a second plane mirror at right angles to the former. How many images are visible to a person standing in front of both mirrors?

K.—REFRACTION AND LENSES.

I. What is meant by the index of refraction of a transparent medium? Explain by the help of a diagram a method of tracing the path of a ray of light in a medium, the angle of incidence of the ray upon the surface of the medium and the index of refraction of the medium being known.

II. If a small object and its image be at a distance of 6 and 2·5 inches in opposite sides of the lens, find the focal length of the lens.

III. The image of a lamp flame is to be formed upon a screen at a distance of 6 feet by means of a convex lens. What is the greatest focal length admissible?

IV. If a candle is placed at a distance of 6 feet from a wall, and a distinct image of the flame is produced upon the wall by a lens held at 1 foot from the candle, show that a distinct image will also be produced when the lens is at 5 feet from the candle; and compare the sizes of the two images.

V. If the refractive index of a ray of light in passing from air to water be $\frac{4}{3}$, and in passing from air to glass be $\frac{3}{2}$, find, by aid of a diagram, what it will be for the ray when passing from water to glass.

VI. A circle an inch in diameter, a convex lens whose focal length is 6 inches, and a second lens whose focal length is 10 inches, are placed so as to have a common axis. The distance from the circle to the first lens is 20 inches, and from the first lens to the second 36 inches. What images of the circle will be formed, and what will be their dimensions?

L.—Effects of Heat.

I. Define latent heat, specific heat, capacity for heat, coefficient of cubic expansion, and thermal conductivity.

II. The latent heat of fusion of ice is 79·5. Its specific gravity is ·917. Ten grammes of metal at 100° C. are immersed in a mixture of ice and water, and the volume of the mixture is found to be reduced by 125 cubic millimetres, without change of temperature. Find the specific heat of the metal.

III. A source of heat is applied equally to the extremities of two similar bars, one of copper and one of iron; and on each bar there is a piece of phosphorus 2 in. from the source of heat. That on the copper takes fire first. Does this experiment entitle us to conclude that copper has a greater thermal conductivity than iron? If not, explain in what respect it is deficient as a proof.

IV. Distinguish between heat and temperature. Compare the quantity of heat necessary to heat one pound of water from 0° to 1° C. with the quantity necessary to convert one pound of ice at 0° into steam at 100° C. (latent heat of water, 79·25; of steam, 536).

V. If the coefficient of expansion of atmospheric air for the centigrade scale be $\frac{1}{273}$, find the temperature to which 500 cubic centimetres of air (measured at 15° C.) must be raised in order that its volume may become 700 cubic centimetres, no change of pressuer taking place meanwhile.

VI. Describe some method of comparing the thermal conductivities of metals.

◆

12.—CHEMISTRY.

A.—Roscoe, Lessons I. to III.

I. Describe the manner in which you would prepare hydrogen, and explain your method.

II. What is meant by *chemical action, elements, oxidation, chemical analysis, diffusive power of gases?*

III. What is meant by a chemical equation? Explain the equation:—$H_2SO_4+Zn=Zn\,SO_4+H_2$.

IV. What temperature on the centigrade scale corresponds to 40° Fahrenheit? Show how you obtain the answer.

V. How is a thermometer made and graduated? Describe the three scales in common use.

VI. Explain by chemical formulae three distinct methods by which oxygen gas can be prepared.

B.—Roscoe, Lessons IV. to VI.

I. Calculate the percentage composition of nitric acid (nitrogen = 14, oxygen = 16, hydrogen = 1).

II. Describe the methods and give sketches of the apparatus you would use to determine the composition of water, (1) by volume, (2) by weight.

III. How would you prepare nitrogen? What effect would an atmosphere of nitrogen produce on life and combustion?

IV. Explain the following equations:—
(i) $KNO_3+H_2SO_4=HNO_3+HKSO_4$;
(ii) $2\,HNO_3=N_2O_5+H_2O$.

V. The ancients used to consider air as one of the elements. Describe properties of air which cause it no longer to be regarded as an element.

VI. What is an eudiometer, and for what purposes is it used? Illustrate by a sketch.

C.—Roscoe, Lessons VII to IX.

I. Carbon is said to exist in three allotropic modifications. Describe fully why diamond, graphite and charcoal are considered to be modifications of the element carbon.

II. How is olefiant gas prepared? What is its composition? and how is it ascertained? Mention the distinguishing characteristics of this compound.

III. If two volumes of marsh gas weighing 16 grammes be burnt in excess of air, how many volumes of carbon dioxide (carbonic acid gas) are produced? also what is the weight of the other compound formed at the same time?

IV. Ammonia gas is passed into water. Describe in detail what takes place.

V. Explain the following equations:—

(i) $3HNO_2=HNO_3+2NO+H_2O$;

(ii) $NH_3+NO_3H=NH_4NO_3$.

VI. One molecule of ammonia, consisting of one atom of nitrogen and three atoms of hydrogen, what is the molecular weight of ammonia?

D.—Roscoe, Lessons X. to XII.

I. What substance is obtained when a piece of sulphur is burned in oxygen? How can this substance be converted into common sulphuric acid? How can you tell whether a specimen of an acid consisted of sulphuric or nitric acid?

II. How is chlorine prepared? Explain the process. If one bottle contained chlorine gas, and the other bromine vapour, how could you distinguish the two substances from one another? Why cannot chlorine exist free in nature?

III. How would you prepare hydrochloric acid from common salt and sulphuric acid? Explain the reaction by means of symbols. How many volumes of chlorine and hydrogen are required for the formation of 100 cubic centimetres of hydrochloric acid?

IV. A gas on analysis is found to consist of equal volumes of chlorine and hydrogen. Describe fully how you would find by experiment whether the gas is a mechanical mixture or a chemical combination of the two elements.

V. How are the compounds of sulphur and oxygen formed? Give their formulae and properties.

VI. Describe an experiment to show that hydrochloric acid gas is composed of equal volumes of its constituents, united without condensation. What is the weight of 11·2 litres of this compound? (Chlorine = 35·5.)

E.—Roscoe, Lessons XIII. and XIV.

I. How do you know that sulphuretted hydrogen is a compound of sulphur and hydrogen?

II. Silica has no taste, and does not act on blue litmus. Why do we call this substance silicic acid?

III. Explain the following equations:—

(i) $3SiF_4+4H_2O=2H_2SiF_6+H_4SiO_4$;
(ii) $PCl_5+H_2O=POCl_3+2HCl$;
(iii) $FeS+H_2SO_4=FeSO_4+H_2S$.

IV. Explain the action of phosphorus pentachloride on strong sulphuric acid.

V. A specimen of spring water is supposed to contain sulphuretted hydrogen (hydric sulphide). How would you ascertain whether any sulphuretted hydrogen is present or not?

VI. What substance is obtained when a piece of sulphur is burned in oxygen? How can this substance be converted into common sulphuric acid? How could you ascertain whether a specimen of an acid consisted of sulphuric or nitric acid?

F.—ROSCOE, LESSONS XV. AND XVI.

I. How much phosphuretted hydrogen PH_3 by weight and by volume would be furnished by 31 grammes of phosphorus, supposing all the phosphorus to be converted into the gas?

II. What substance is formed when a piece of dry phosphorus is burnt in an excess of dry air? Give the formula of the phosphorus compound produced, and explain how it is acted upon by boiling water.

III. Explain the chemical reaction which occurs when phosphorus and milk of lime are boiled together. How do you account for ordinary phosphuretted hydrogen losing its property of spontaneous inflammability when kept for some time at a low temperature?

IV. Explain the following equations:—

(i) $NH_3+HCl=NH_4Cl$;

(ii) $PCl_5+H_2o=PoCl_3+2HCl$.

V. Explain the different methods by which the presence of arsenic can be detected.

VI. What is arsenic trioxide? Explain its formation, also that of arsenic pentoxide.

APPENDIX II.

SOLUTIONS TO THE MATHEMATICAL QUESTIONS.

ARITHMETIC.

A.

III. 157026. IV. 7758000. V. 1753.

£ *s.* *d.*
VII. 21 ft. $1\frac{3}{4}$ in. VIII. 63 yds. $2\frac{1}{10}$ ft.; 11 18 $10\frac{1}{2}$.

B.

£
I. $\frac{1}{19}$; $\frac{1}{7600}$; $\frac{31}{800}$.

£ *s.* *d.*
II. $\frac{181}{480}$; 405 10 5.

III. $\frac{300}{420}$, $\frac{385}{420}$, $\frac{390}{420}$, $\frac{392}{420}$, $\frac{357}{420}$, $\frac{380}{420}$.

£ *s.*
IV. $\frac{3}{8}$. V. $\frac{102}{133}$; $1\frac{607}{1092}$. VI. 22 16.

C.

I. 83·25; 2812·5. II. 17·8609375 Tr. 14·697 Av.

III. ·0002929678. IV. 808. V. ·3125. VI. $\frac{8}{35}$.

D.

£ *s.* *d.* £ *s.* *hr.* *min.* *secs.*
II. 11 13 4. III. 627 12. IV. 1 18 45.

£ *s.* *d.* £ *s.*
V. 786 2 $9\frac{3}{29}$. VI. 40 8.

E.

£ £ *s.* *d.*
I. 1,050. II. $3\frac{1}{2}$ per cent. III. 1,303 6 8.

£ *s.* *d.* £
IV. 15 15 3; 1,225. V. $1\frac{1}{4}$ per cent.

£ *s.* *d.*
VI. 3 per cent.; 51 4 $0\frac{1}{2}$.

F.

£ *s.* *d.* £ *s.* *d.* £ *s.* *d.*
I. 173 4 $9\frac{5}{8}$. II. 1,211 0 $8\frac{39}{227}$. III. 23 6 8.

£ *s.* £ *s.*
IV. 130 4. V. 792 15. VI. 5 per cent.

G.

£ £ £ £ £ £ £
I. 112, 224, 336, 448. II. 630, 420, 315. III. 8, 12, 16.
£ £ £
IV. 20, 21, 25.
V. Water, ·532 lb.; alcohol, ·467 lbs.; the mixture, 1·878 lbs.
VI. Man's share, £1; woman's, 16*s.* 8*d.*; boy's, 16*s.*; girl's, 15*s.*

H.

s.
I. 5 per ton. II. He loses 80 per cent.
s. *d.* *s.*
III. 2 lbs. at 5 6 to 1 lb. at 4.
IV. 1st, 20 per cent.; 2nd, $16\frac{2}{3}$ per cent.

I.

£ *s.* *d.* £ *s.* *d.* £ £ *s.*
I. 14 1 9; 183 2 9. II. 1920. III. 31 5.
£ £ £ £
IV. 723; 3·3195 per cent. V. 8,000; 7,530. VI. 75.

J.

I. 12·5; ·08; ·2529822+. II. 436; 2846+.
III. 23·002. IV. 1·6407+. V. $6\frac{7}{15}$
VI. ·94868; 19·48558.

K.

I. 1605. III. $36\frac{3}{13}$. IV. $71\frac{20}{51}$. V. $5\frac{1}{2}$ ft.
VI. $2\cdot223\dot{4}$.

L.

£ *s.* *d.*
II. 120 lbs. III. 48. IV. $981\frac{2}{3}$. V. 14 4 $6\frac{28}{41}$.
VI. $5\frac{1}{2}$ lbs.

◆

ALGEBRA.

A.

I. 0. II. $a^2 + b^2 + c^2 - ab - ac - bc$. III. $-2a + 3b$.
IV. $x^5 - 32a^5$. V. $12ax + 2xy$; $x - 2$.
VI. $2x^2 - 19xy + y^2$.

B.

I. 3. II. 12. III. 60. IV. $4\frac{2}{5}$. V. 9, 27.
VI. 63.

C.

I. (a) $(x - 5)(x - 10)$. (b) $(a + 4b)(a + 5b)$.
(c) $(2x + 2y - a - b)(x + y - 3a - 3b)$.

II. $a^2 + b^2 + c^2$.
III. (a) $(x + a)^2$. (b) $a + b + c + d$.
(c) $-6c^2 + c(9a + 4b) - 6ab$.

D.

II. (i) $x + 5$. (ii) $x - 4$. (iii) $x^2 + 1$. (iv) $x + 3y$.
III. (i) $12ab(a^2 + b^2)$. (ii) $(x^2 - 5x + 6)(x - 1)(x - 4)$.
(iii) $x^6 - 1$. (iv) $(x^2 - 9x - 30)(x^2 + 5x + 10)$.

E.

I. (i) $2a^3x^3 + 6axb^2y^2$.
(ii) $1 - 9x + 36x^2 - 81x^3 + 108x^4 - 81x^5 + 27x^6$.
(iii) $4(ab + ad + bc + cd)$.
(iv) $1 - 3x^3 + 3x^6 - x^9$.

II. (i) $6x^3 + 1$. (ii) $\frac{3x^2 - 4}{2x - 3}$. (iii) $x^2 - ax + 2a^2$.
(iv) $1 - x + x^2 - x^3 + x^4$.

III. (i) $12x^2 + 4y^2$. (ii) $x - a - b$. (iii) $x^2 - ax - a^2$.
(iv) $1 - x + x^2 - x^3$.

F.

I. 1. II. $\frac{x^2 - bx + 2}{x^2 - 5x + 3}$. III. $x + 3$. IV. $1 + \frac{b}{a}$.
V. $\frac{4x^2 - 3x - 4}{5x^2 - 4x - 3}$. VI. $\frac{a^2b^2}{a^4 - b^4}$; $\frac{4}{15}b^2$.

G.

I. $x=6$, $y=7$. II. $x=144$, $y=216$. III. $x=4$, $y=3$, $z=2$.
IV. $x=4$, $y=5$, $z=6$. V. $x=20$, $y=12$. VI. $x=4$, $y=2$.

H.

I. 5, $\frac{2}{3}$. II. 6, $\frac{9}{4}$. III. ± 2. IV. 3, -5.
V. $a \pm \frac{1}{a}$. VI. a, $-\frac{6(a + b)}{2a + b}$.

I.

I. 15. II. 75, $15\frac{6}{7}$. III. n^2; $n(n + 1$; $n : n + 1)$.
IV. 18, 19. V. 1, 4, 7. VI. 1, 2.

J.

I. 12. II. $\frac{248}{2045}$; $\frac{2}{3}$; $\frac{4^n - 1}{4^n - 1}$; $\frac{8}{9}$. III. 4×3^9; $2(3^{10} - 1)$.

IV. $\frac{3^{2n} - 1}{2 \times 3^{2n} - 1}$; $\frac{3^{2n} - 1}{4 \times 3^{2n}}$; 2 : 1. V. 1, 3, 9. VI. 3, 6, 12.

GEOMETRY.

A.

II. I. 5. III. Take a straight line; produce it both ways, making each of the lines produced equal to the original line. Describe circles and, from the point where the circles intersect, draw straight lines to the points of the original line, to form a triangle. This will be the triangle required. IV. I. 11. V. Join the two points, and bisect the line thus formed. Draw a perpendicular to this line meeting the original line. The point where this perpendicular meets the original line will be the point required. VI. I. 21.

B.

I. I. 35. II. Take a quadrilateral and draw the diagonal and prove the opposite sides parallel by alternate angles (see I. 34.) III. I. 43. IV. Bisect the vertical angle; and from the point where the bisecting line meets the base draw lines parallel to the sides of the triangle. These lines drawn from this point in the base shall be equal. V. I. 47. VI. Take the middle points of the sides of the triangle and join them. Draw lines from each of these points to the extremities of the base. Then there are two equal triangles on same base, and ∴ between same parallels.

C.

I. II. 4. II. Let RS be given straight line, and on it describe a square RSQP. Join QR. Bisect angles SQR, RSQ by straight lines meeting in T. Through T draw UTV parallel to RQ meeting RS in U. RS is divided in U as required. III. II. 11. IV. Take any quadrilateral LMNO. Take the middle points of each side P, Q, R, S. Join LN, MO, SP, PQ, QR, RS, SQ, PR. Then since PS and QR are each of them parallel to, and half of, MO and PQ, SR parallel to and half of LN, and since the square on a line = 4 times the square on half the line, the squares on MO, LN = 4 times the squares on SP, PQ, or twice the squares on SP, PQ, QR, RS. And since SPQR is a parallelogram, the squares on SQ, PR = squares on SP, PQ, QR, RS, ∴ squares on MO, LN = twice squares on SQ, PR. Q.E.D. V. II. 13. VI. Let ABC be the triangle, with AC for hypotenuse. Produce AB to D, making BD = BC. Then (by II. 4) the square on AD = squares on AB, BD + 2 rectangle AB, BD. Now the squares on AB, BD = square on AC = 2 rectangle AB, BD, ∴ square on AD = 4 rectangle AB, BD. If E be middle part of AB, the square on AD = 4 times square on AE. Hence the rectangle AB, BD = square on AE. But square on AE = rectangle AB, BD + square on EB. Hence E and B must coincide, ∴ AB = BD = BC. Hence ABC is isosceles. Q.E.D.

D.

I. III. 12. II. Let the two circles touch one another in the point H. Draw parallel diameters MN, OP through the centres K. and L, and join NP, HN, HP. Draw the straight line HKL. Then ∵ MN is parallel to OP, the angle HKN = angle KLP. But HKN is double of KHN, and KLP is double of LHP, ∴ the angle HKN = angle LHP, *i.e.* HN and HP coincide, ∴ PN passes through the point of contact. Q.E.D. III. III. 15. IV. Let OPQ be given circle, and M the given point within it. Take centre L. and join LM. Through M. draw the chord OP perpendicular to LM. This shall be the shortest possible chord through M. For take any other chord QR, and from L draw LS perpendicular to QR. Then in the triangle LSM, LSM being a right angle, is greater than LMS, ∴ LM is greater than LS, *i.e.* QR is nearer the centre than OP, and is therefore greater than OP. Hence OP is the shortest possible chord through M. V. iii. 18. VI. Take a line PQ, and let R be the centre of the given circle. From R draw RS perpendicular to PQ, cutting the circumference in T. From T draw TU at right angles to RS. TU touches the circle. And ∵ RTU and TSQ are both right angles, and ∴ equal, TU is parallel to PQ.

E.

I. iii. 26. II. Take P the centre of the circle, and draw the diameter QPR. On QP describe an equilateral triangle QSP, and join SR. Then the angle SQP, being an angle of an equilateral triangle, = $\frac{2}{3}$ right angle. Hence the angle in the segment SQR = $\frac{2}{3}$ right angle. Take any point T in the other segment and join ST, TR. Then QSTR being a quadrilateral figure inscribed in a circle, the opposite angles SQR, STR = 2 right angles. But SQR = $\frac{2}{3}$ right angle. Hence STR = $\frac{4}{3}$ right angle and is ∴ double of SQR. Hence SQR, STR are the 2 segments required III. iii. 31. IV. Draw the parallel chords and join their extremities. Prove the equalities by iii. 21 and i. 26. V. iii. 34. VI. Draw the two intersecting circles, and a common chord PQ. Let RS be the common tangent, touching the circles in R and S. Produce QP to meet RS in T. Then RT = TS, since the square on each = rectangle QT, TP.

F.

I. iv. 4. II. Take the common centre D and join it with the vertex of the triangle ABC; and from it draw perpendiculars DE, DF, DG to each of the sides of the triangle. These sides will thus be bisected. Then by i. 47 the square on AD = squares on AE, ED; similarly square on AD = squares on AG, GD, ∴ squares on AE, ED = squares on AG, GD; and square on ED = square on GD, ∴ square on

AE = square on AG, ∴ AE = AG. But AB is double of AE, and AC is double of AG, ∴ AB = AC. Similarly it may be shown that BC = AC = AB, and hence the triangle is equilateral. III. IV. 10. IV. Let PQ be the given points, and RS the given straight line. Join PQ and produce it to meet RS in T. From TR cut off TU, so that square on TU = rectangle TP, PQ. Through P, Q, U, describe a circle. This shall be the circle required. V. IV. 16. VI. Prove that the triangles formed by joining the middle points of the sides of the regular hexagon = $\frac{1}{4}$ of hexagon. Hence remainder, *i. e.* new hexagon, = $\frac{3}{4}$ original hexagon.

G.

I. I. 26. II. Let AB be the base, C the given angle, and DE the sum of the sides. At point A in BA make angle BAF = angle C. From AF cut off AG = DE. Join GB, and at point B in GB make the angle GBH = angle AGB. Produce BH to meet AG in K. KAB is the triangle required. III. I. 29. IV. We prove the two triangles on same base BC and on the same side of it to be equal. Hence they are between the same parallels, ∴ DE is parallel to BC. V. I. 33. VI. Let PQRS be a quadrilateral figure, having PS parallel to QR, and PQ = but not parallel to SR. The angles PQR and PSR shall = 2 right angles. Produce PS to T, making PT = QR, and join TR. Then ∵ PT is = and parallel to SR, PQ is = and parallel to TR, and hence PQRT is a parallelogram, ∴ the angle PQR = angle PTR, and TR = PQ = SR, ∴ the angle RTS = angle RST, ∴ since PQR and PTR = 2 right angles, PQR and PSR also = 2 right angles.

H.

I. II. 5. II. Take any parallelogram PQRS. Draw the diagonals PR, SQ. From P and Q draw PT and QU perpendicular to SR. Then in the triangles

PST, QRU, we have 2 angles of the one = 2 angles of the other, each to each, and one side PS = to one side QR, ∴ the other sides are equal, ∴ ST = UR. Again, the square on QS = squares on QR, RS + 2 rectangle SR, RU. Also square on PR = squares on PS, SR — 2 rectangle ST, SR. But ST = UR, ∴ rectangle SR, RU = rectangle ST, SR. Hence squares on QS, PR = squares on QR, PS, and twice square on SR, *i.e.* squares on the four sides. Q.E.D. III. II. 10. IV. Let ABC be the isosceles triangle, and D. the point in the base. Join AD and draw AE perpendicular to BC. Then in the triangles ABE, AEC we have 2 angles = 2 angles and one side AE common to both, ∴ the other sides are equal. Hence BE = EC. And ∵ square on AB = squares on AE, EB, and square on A D = squares on AE, ED, ∴ square on AB exceeds the square on AD by the difference between the squares on BE and DE. And ∵ BC is divided into 2 equal parts at E and 2 unequal parts at D, ∴ square on BE = square on DE + 2 rectangle BD, DC. Hence the square on BE exceeds the square on DE by 2 rectangle BD, DC, ∴ also square on AB exceeds square on AD by 2 rectangle BD, DC. Q.E.D. V. II. 14. VI. Let PR be the given side. Draw RQ perpendicular to PR and = to one side of the given square. Join PQ, and at point Q in PQ make the angle PQS = angle QPT, cutting PR in S. Then ∵ angle PQS = angle QSP, QS = SP. Produce PR to T, making ST = SQ or SP. Then the rectangle PR, RT shall be the rectangle required. For ∴ square on SQ = squares on SR, RQ, and square on SQ = square on ST, ∴ square on ST = squares on SR, RQ. But square on ST = square on SR + rectangle PR, RT, ∴ squares on SR, RQ = square on SR + rectangle PR, RT, ∴ rectangle PR, RT = square on RQ. Q.E.F.

I.

I. III. 20. II. Let P be the given point and PQ the given straight line; RST the given circle. Take the centre U and from PQ cut off PV = the radius UR. Join UV and at the point U in the straight line VU make the angle VUW = angle UVW, meeting PQ in W. Produce WU to meet the circumference in X. Then WX = WP, and the circle described from centre W at distance WX or WP will be the circle required. III. III. 22. IV. Take a quadrilateral, FGHK, and let it touch the circle in points MNOP. Take L the centre of circle and join LM, LF, LN. Then ∵ the angles at M and N are right angles, the square on FL = squares on LN, NF, also squares on LM, MF. But the square on LN = square on LM, ∴ square on NF = square on MF, ∴ NF = MF. Similarly MK = KP, PH = HO and OG = GN, ∴ FK + GH = KH + FG. Q.E.D. V. III. 36. VI. Let ABC be an isosceles triangle. Bisect AB, BC, CA in E, D, F. Join ED, FD, AD. Then EDFA is a parallelogram, ∴ AF = ED and AE = DF, ∴ ED = DF, and each is equal to half of a side of the isosceles triangle. Hence the circles whose diameters are AB, AC will intersect at D.

J.

I. IV. 7. II. Let PQ, PR touch the circle QSR in points Q and R. Take T the centre of the circle. Join PT, cutting the circle in U. Draw WUX, touching the circle and meeting PQ, PR in W and X. Bisect the angle PWU by WY, meeting PU in Y. From Y draw YZ, YV perpendicular to PQ, PR. Then YZ = YU; and the circle described from centre Y at distance of either will be the circle required. III. IV. 11. IV. Let AB be the given base. Describe a triangle with each of the angles at base double of the vertical angle.

At point A in AB make the angle BAC = angle at vertex, and at point B in AB make the angle ABC = angle at base. Then ACB = the other angle at base. Bisect angle ABC by BD, meeting AC in D. Then ADB is the triangle required. V. IV. 13.

VI. Let LM be the given line. On LM describe an equilateral triangle LMN; and on LM, NM the sides of this triangle describe the equilateral triangles NPL, NQM. Produce LN, MN to R and S, making NR, NS each = to LM. Join PS, SR, RQ. Then PLMQRS is the hexagon required.

◆

NATURAL PHILOSOPHY.

A.

II. $\sqrt{201}$, $\sqrt{146}$, $\sqrt{91}$.

IV. AD is resultant of AB, AC. Thus we have two forces, BD and AD. Produce BD to E, making DE = BD. Complete parallelogram. Then AD, AC are the forces, and AE (= CD = AB) the resultant.

V. 10 lbs.

B.

I. $10\sqrt{3}$. II. 3·2. IV. $\frac{4\sqrt{3}}{3}$.

V. P = 8, Q = 9.

VI. Centre of gravity = $\frac{1}{27}$ of the line joining the right angle with the middle point of the hypotenuse from this point.

C.

II. 492 grammes. III. $5\frac{1}{7}$, $13\frac{1}{7}$, $29\frac{1}{7}$, $61\frac{1}{7}$.

IV. (a) 5 pulleys; (b) 4 pulleys. V. 24·495.

D.

I. $3\sqrt{3}$ lbs.

II. (a) Angle 60°. Resistance of plane $6\sqrt{3}$; (b) when the power acts vertically upwards, R = O.

IV. $\frac{1}{2}$ in. V. $P = \frac{1}{\sqrt{3}}$.

VI. Height : length : : 3 : 5 or the plane rises 3 inches in 5 inches.

E.

II. $320\sqrt{5}$ ft. per second.
III. (a) 225 ft. ; (b) when it has reached a height of 200 ft.
IV. (a) $4\frac{2}{5}$ ft. ; (b) ·16 ft.
V. 2 ft. per second.
VI. 1,200 ft. per second.

F.

I. $4\frac{1}{2}$. II. 980 centimetres per second. IV. 25 ft.
VI. $1\frac{1}{2}$ ft.

G.

II. 2,500 lbs. IV. $187\frac{1}{2}$ ounces. V. 4 metres.
VI. 28 lbs. (nearly).

H.

II. 2·315. IV. ·9375. V. $64\frac{2}{11}$ grains. VI. 2·5.

I.

II. ·000078 (nearly). III. 8 grains (nearly). IV. $28\cdot0\dot{3}$.
V. The mass, being proportional to the volume, must vary with the depth. VI. ·43046721.

J.

I. The distance of the image from the mirror is 1 foot ; it is inverted, real and $\frac{1}{2}$ the size of the object. III. 3 inches. IV. 3 feet. V. The objects will be 3 inches in front of the mirror, and the image $1\frac{1}{2}$ inch behind. VI. 3.

K.

II. 1·76. III. $1\frac{1}{2}$. IV. The sizes are as 25 : 1.
V. $\frac{9}{8}$. VI. $\frac{3}{7}$ in., $\frac{15}{16}$ in.

L.

II. ·1104. IV. Taking x as the quantity necessary for the first operation and as the thermal unit, 715·25 thermal units will be required. V. 130·2.

PRINTED BY C. F. ROWORTH, BREAM'S BUILDINGS, CHANCERY LANE, E.C.